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# United States Patent [19]

**Shibata et al.**

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[45] **Date of Patent: Aug. 5, 1997**

[54] **KEY SWITCH SYSTEM FOR A VEHICLE**


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[73] Assignee: **Honda Giken Kogyo Kabushiki Kaisha**, Tokyo, Japan



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§ 371 Date: **Dec. 21, 1995**

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PCT Pub. Date: **Aug. 10, 1995**

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| Jan. 23, 1995 | [JP] | Japan | 7-008540 |

[51] **Int. Cl.**[6] .......... **B60R 25/02**

[52] **U.S. Cl.** .......... **70/185**; 70/186; 70/252; 70/492

[58] **Field of Search** .......... 70/252, 182–186, 70/DIG. 30, 421, 492, 360


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*Attorney, Agent, or Firm*—Nikaido, Marmelstein, Murray & Oram LLP

[57] **ABSTRACT**


In a key switch system for a vehicle, a plurality of tumblers **6** and a pair of cylinder pins engaging tumbler engagement grooves $\mathbf{1_2}$ in an outer cylinder **1** are radially slidably carried in an inner cylinder **2** which is rotatably carried within the outer cylinder **1**. If a key K is correctly and deeply inserted into a key hole $\mathbf{2_1}$, the tumblers **6** are disengaged from the tumbler engagement grooves $\mathbf{1_2}$ by a code valley $K_1$ of the key K, and the pair of cylinder pins **8** are disengaged from the tumbler engagement grooves $\mathbf{1_2}$ by a tip end $K_2$ of the key K, thereby permitting the rotation of the inner cylinder **2**. If the key K is turned in a state in which it is not correctly and deeply inserted into the key hole $\mathbf{2_1}$, the rotation is restricted by the engagement of the cylinder pins **8** having a high rigidity into the tumbler engagement grooves $\mathbf{1_2}$, thereby preventing a damage to the tumblers **6**.


**4 Claims, 17 Drawing Sheets**

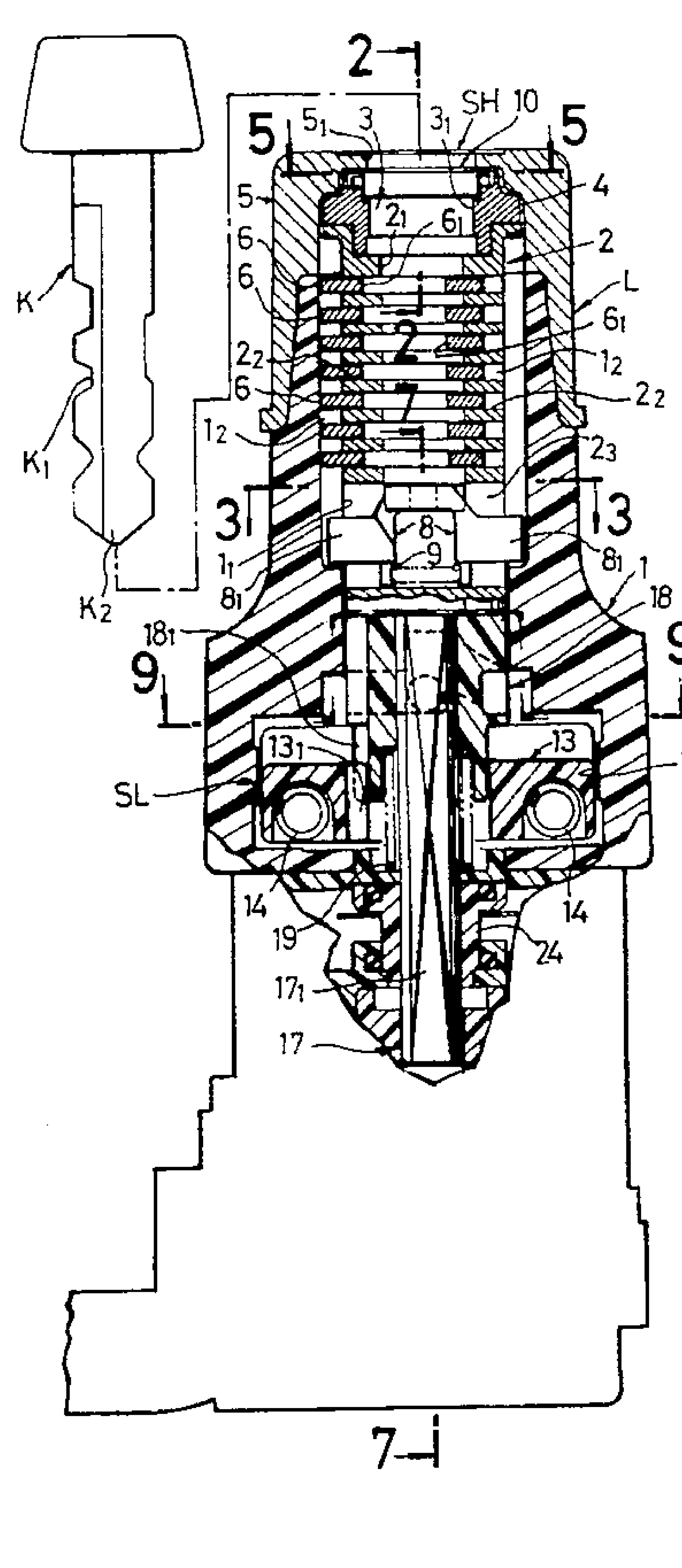
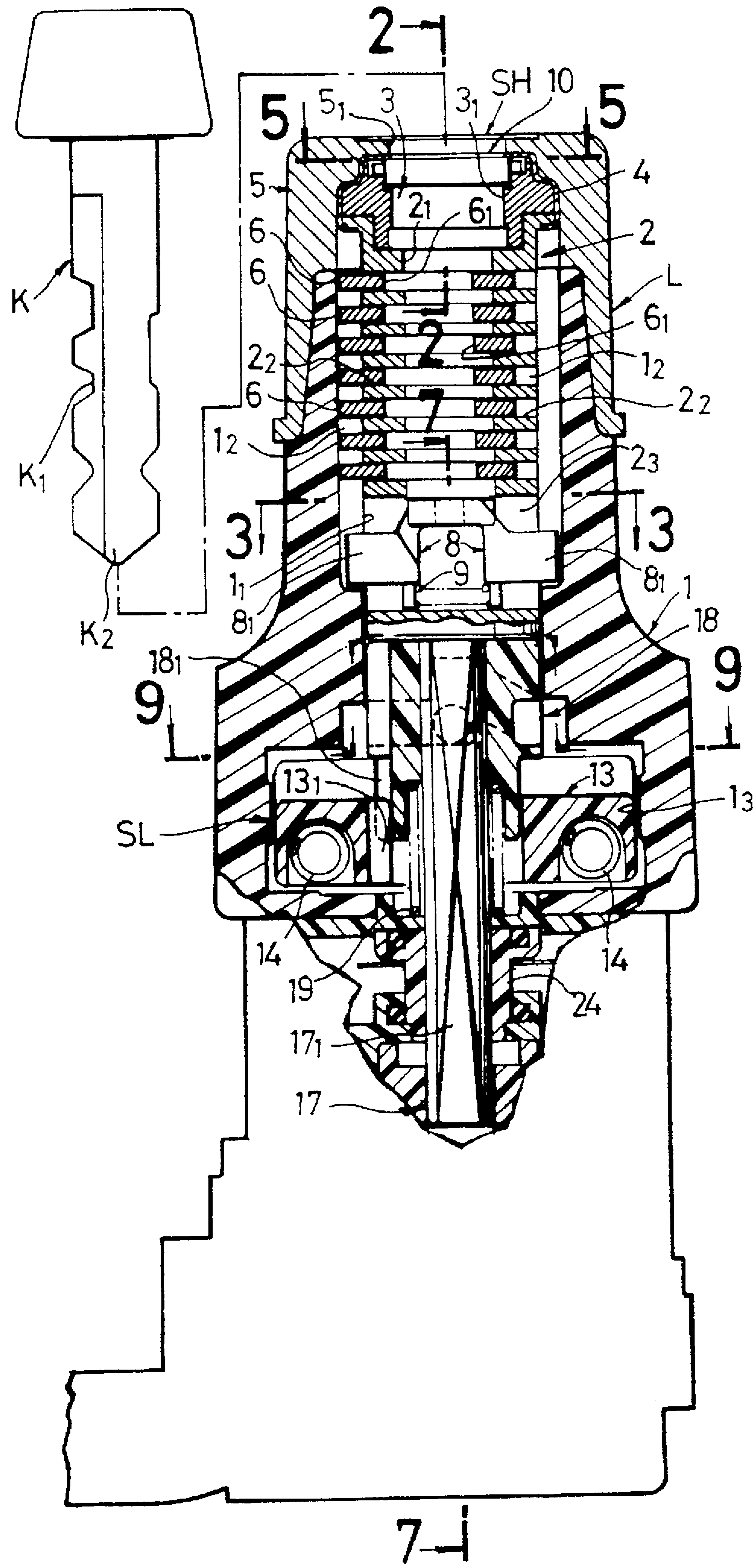


FIG. 1



2
5
$5_1$
3
$3_1$
SH
10
4
5
6
$2_1$
$6_1$
2
L
K
$2_2$
$1_2$
$K_1$
3
$1_1$
$8_1$
8
9
$2_3$
1
18
$K_2$
$18_1$
9
$13_1$
13
$1_3$
SL
14
19
24
$17_1$
17
7

FIG.2

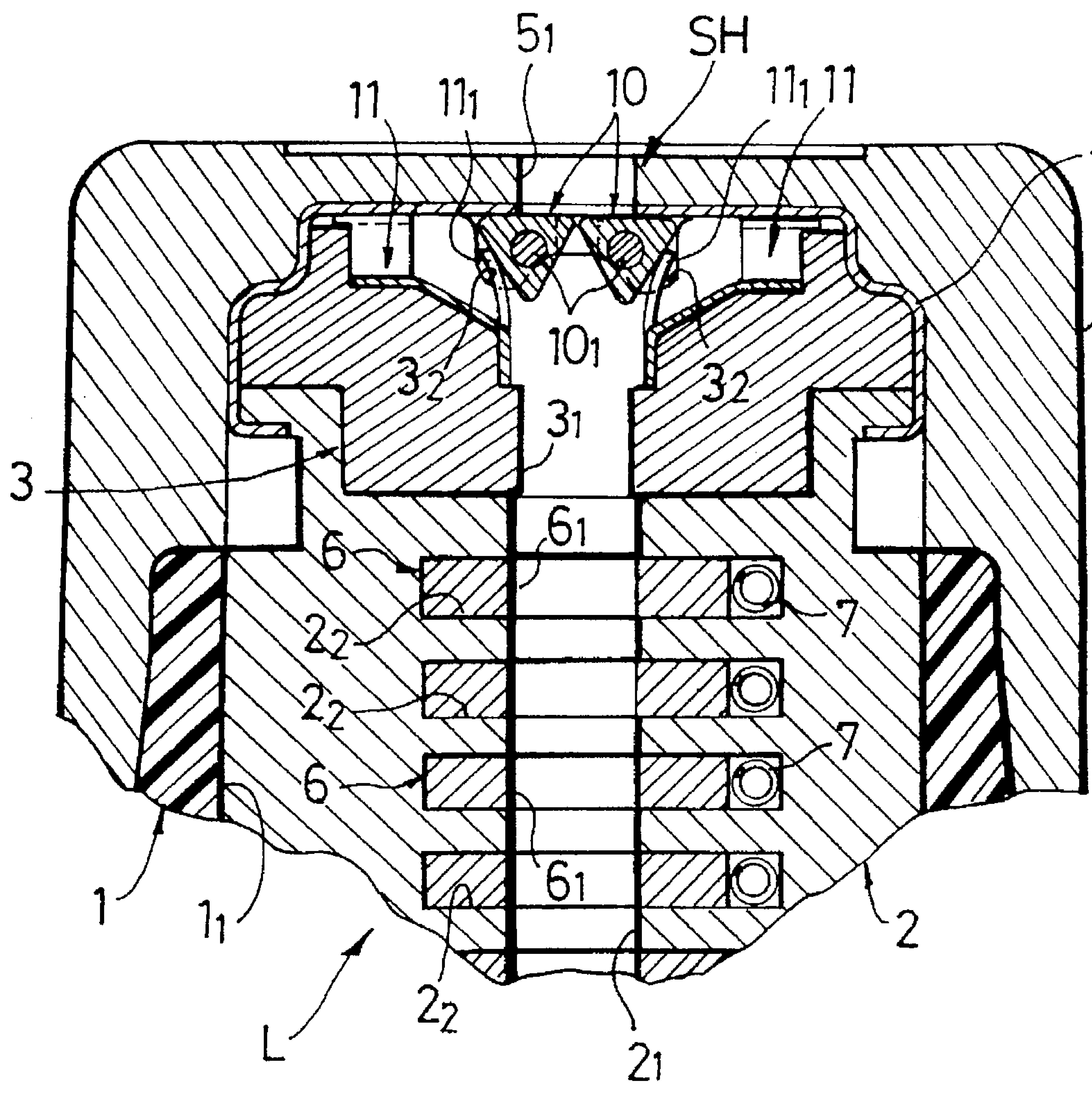


FIG.3A

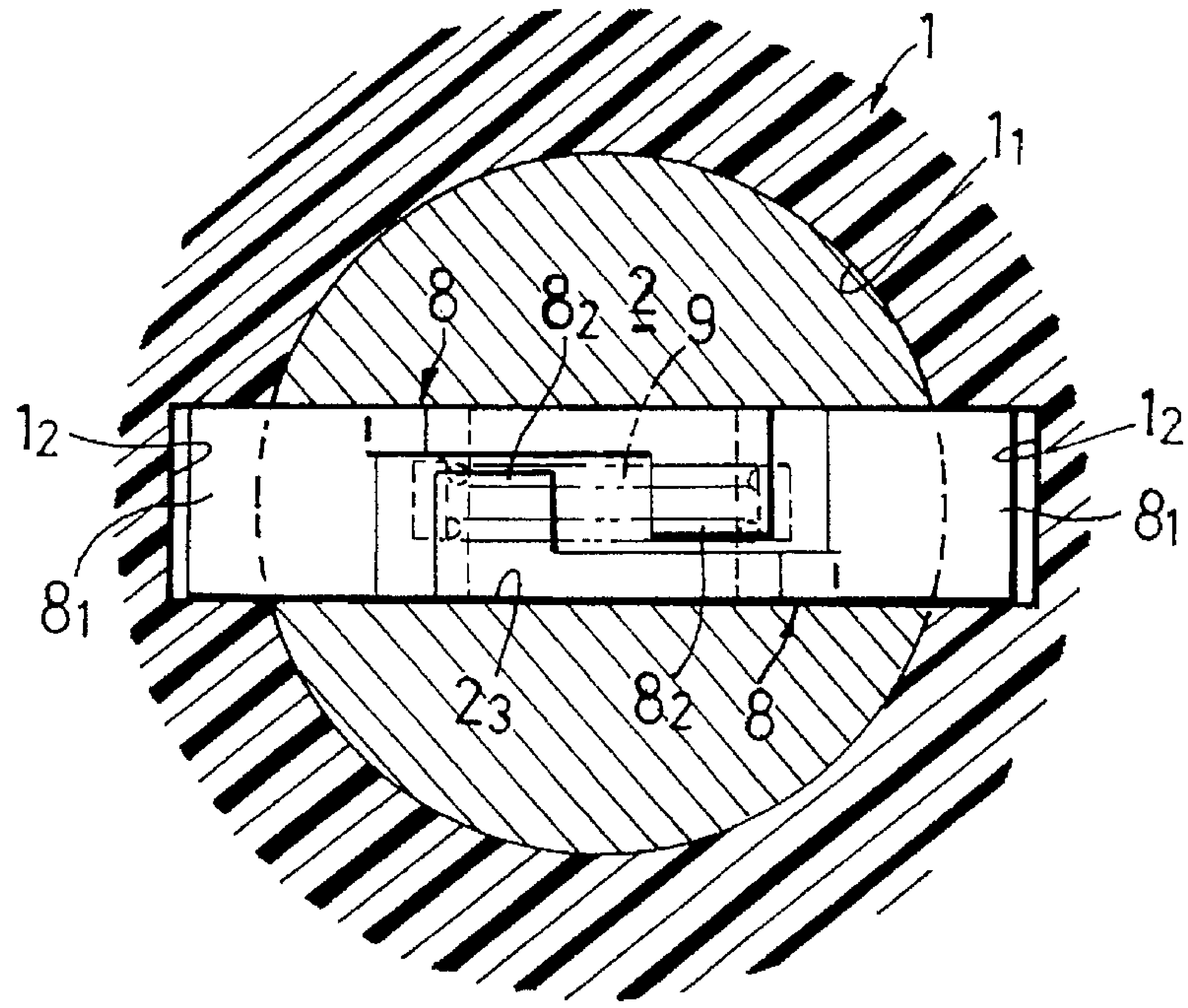



FIG.3B

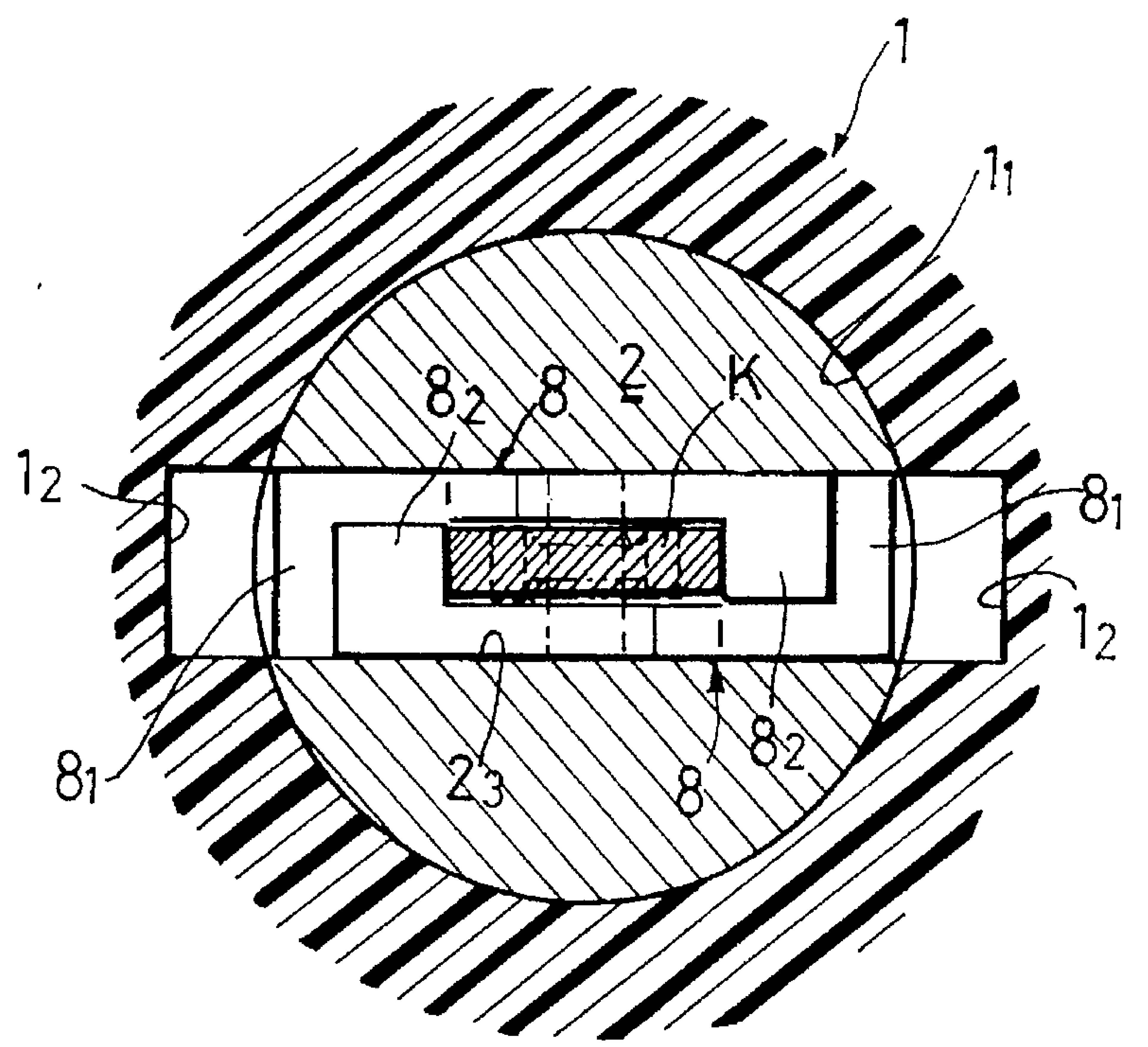


FIG.4

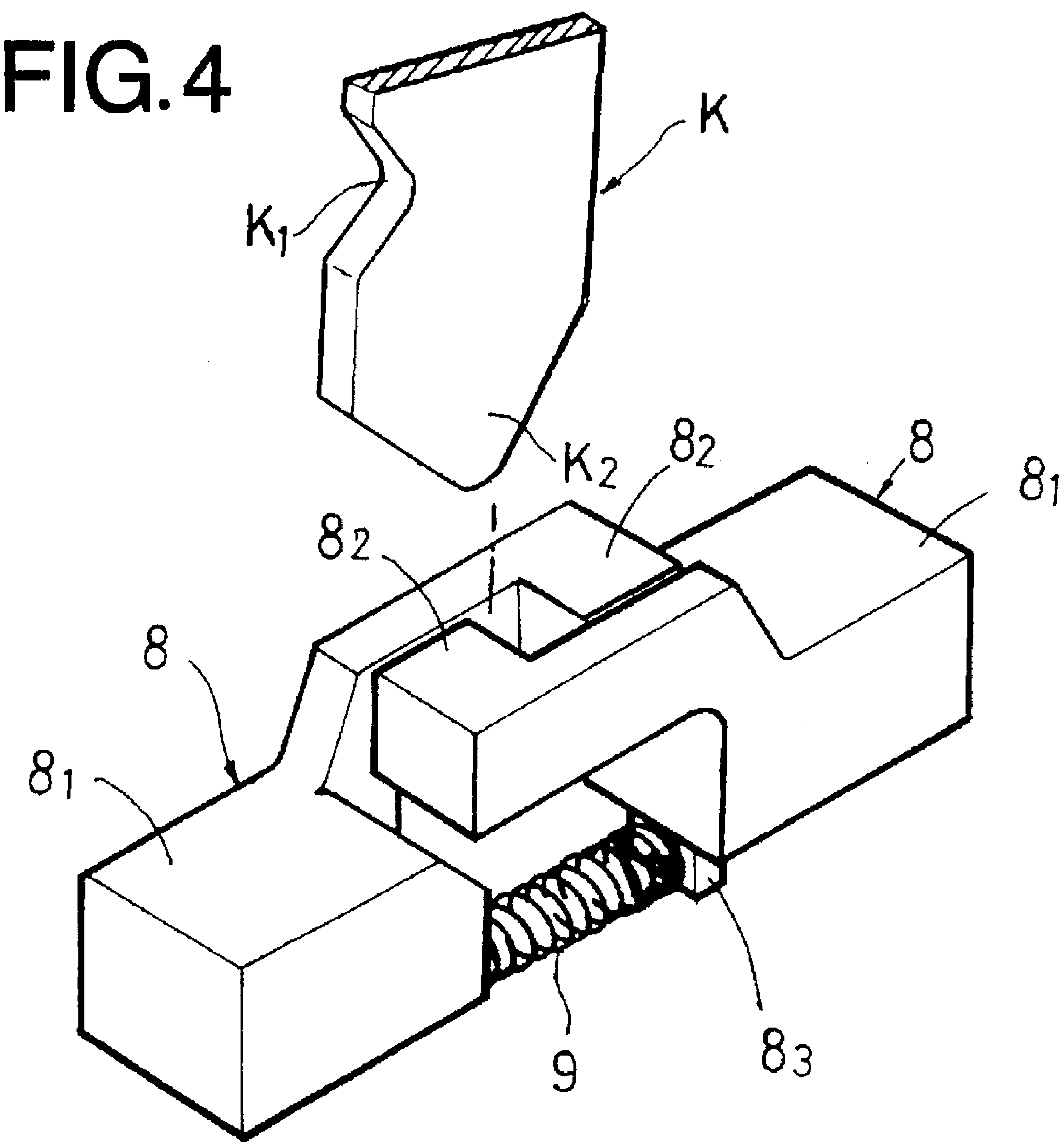

K
K1
K2
82
8
81
82
8
81
9
83

FIG.5

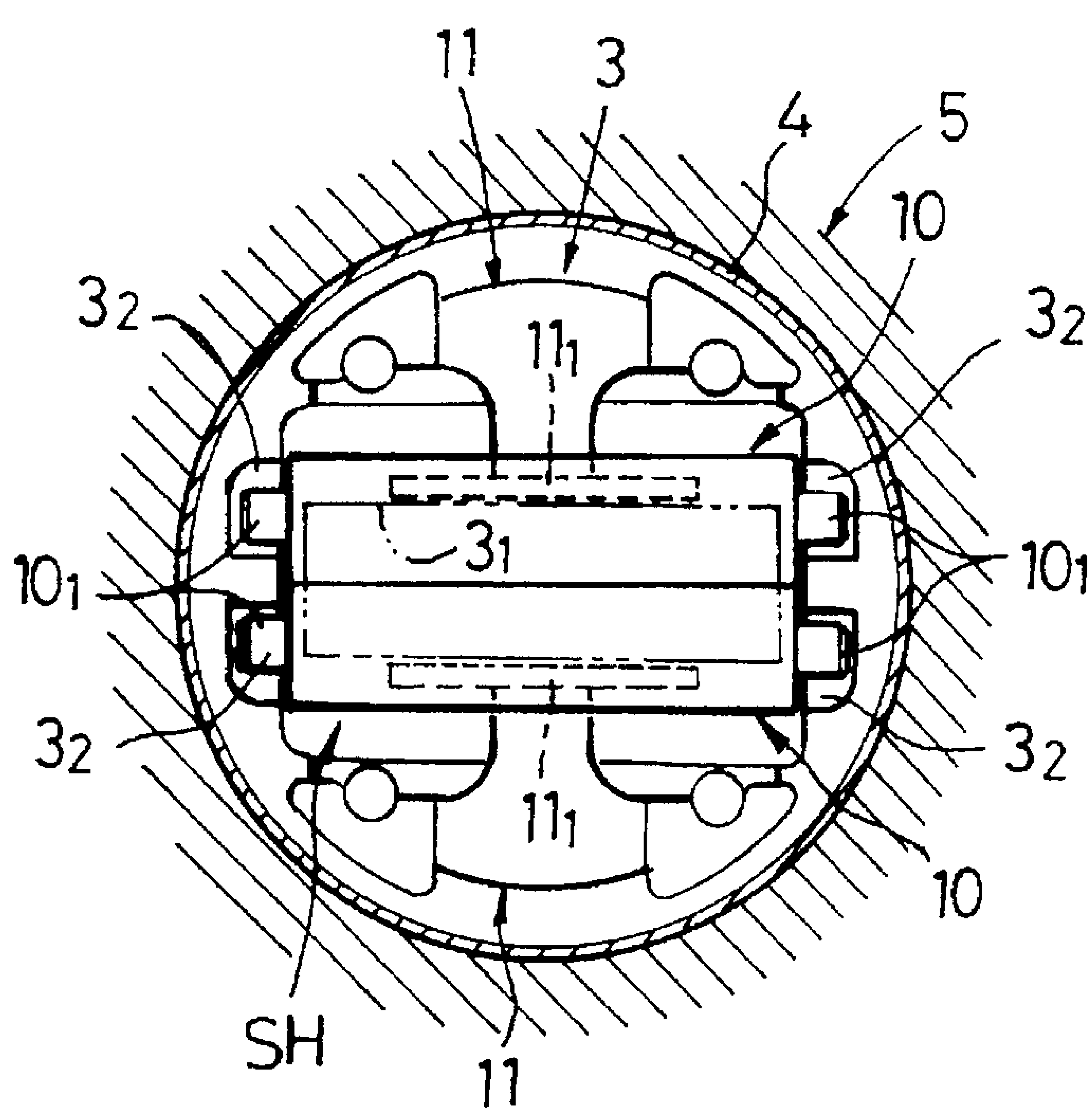

11
3
4
5
10
32
111
32
31
101
101
32
32
111
10
SH
11

FIG.6A

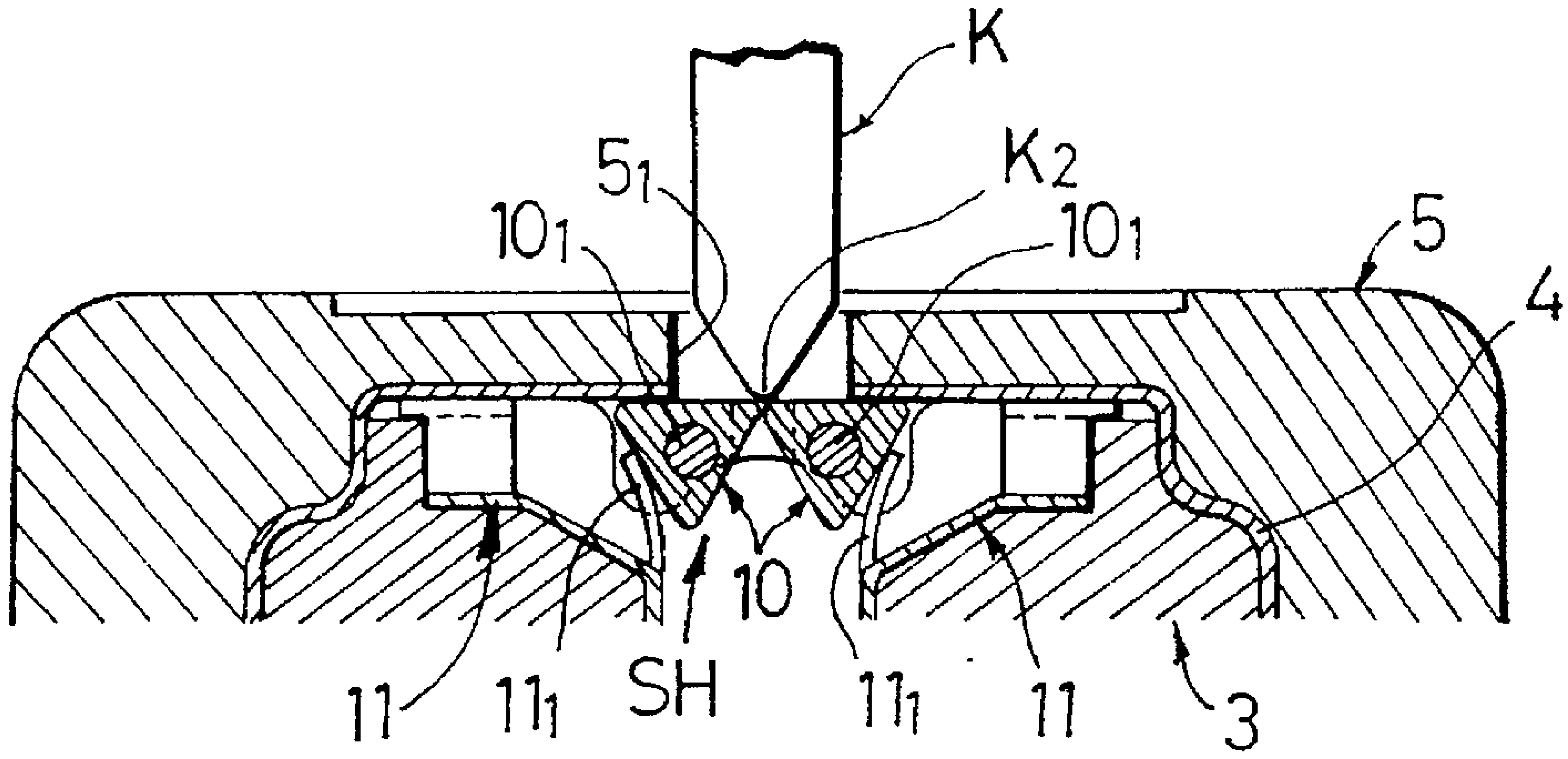



FIG.6B

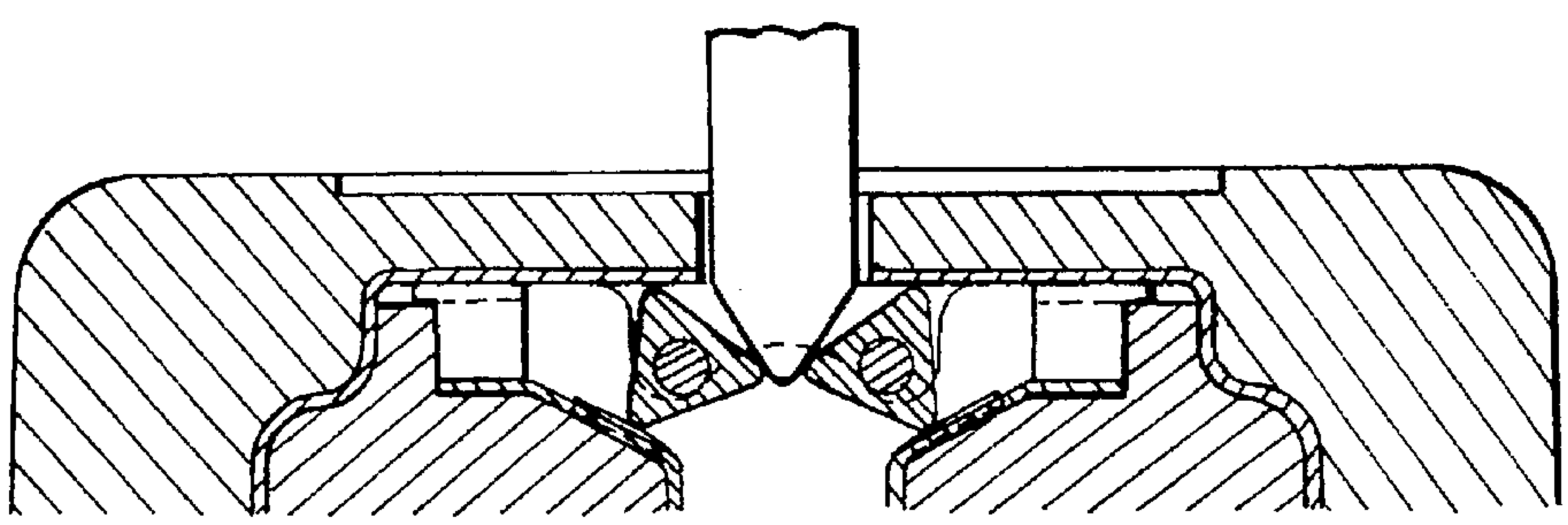


FIG.6C

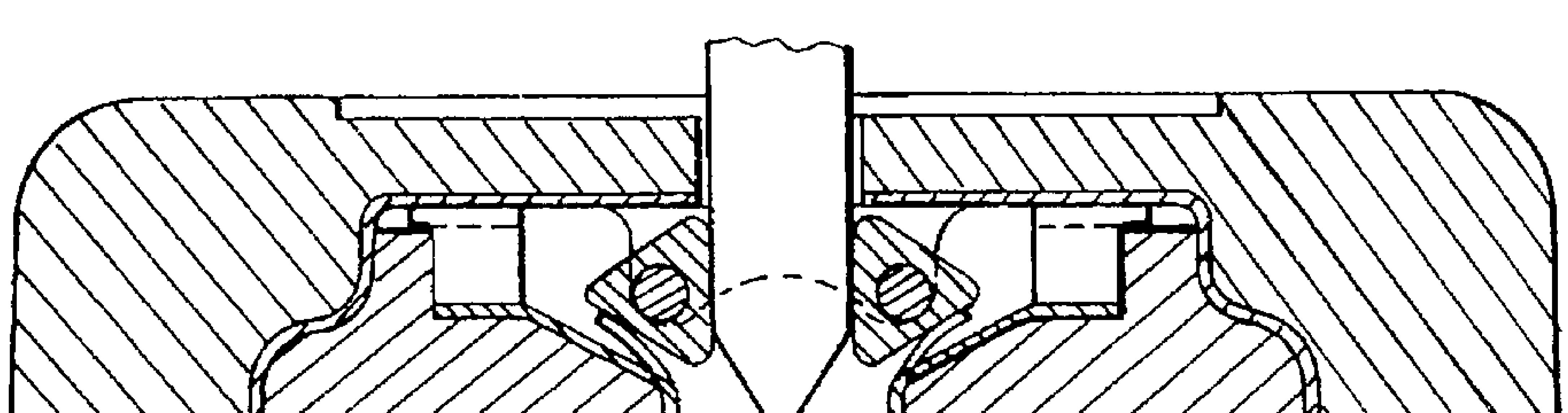


FIG. 7

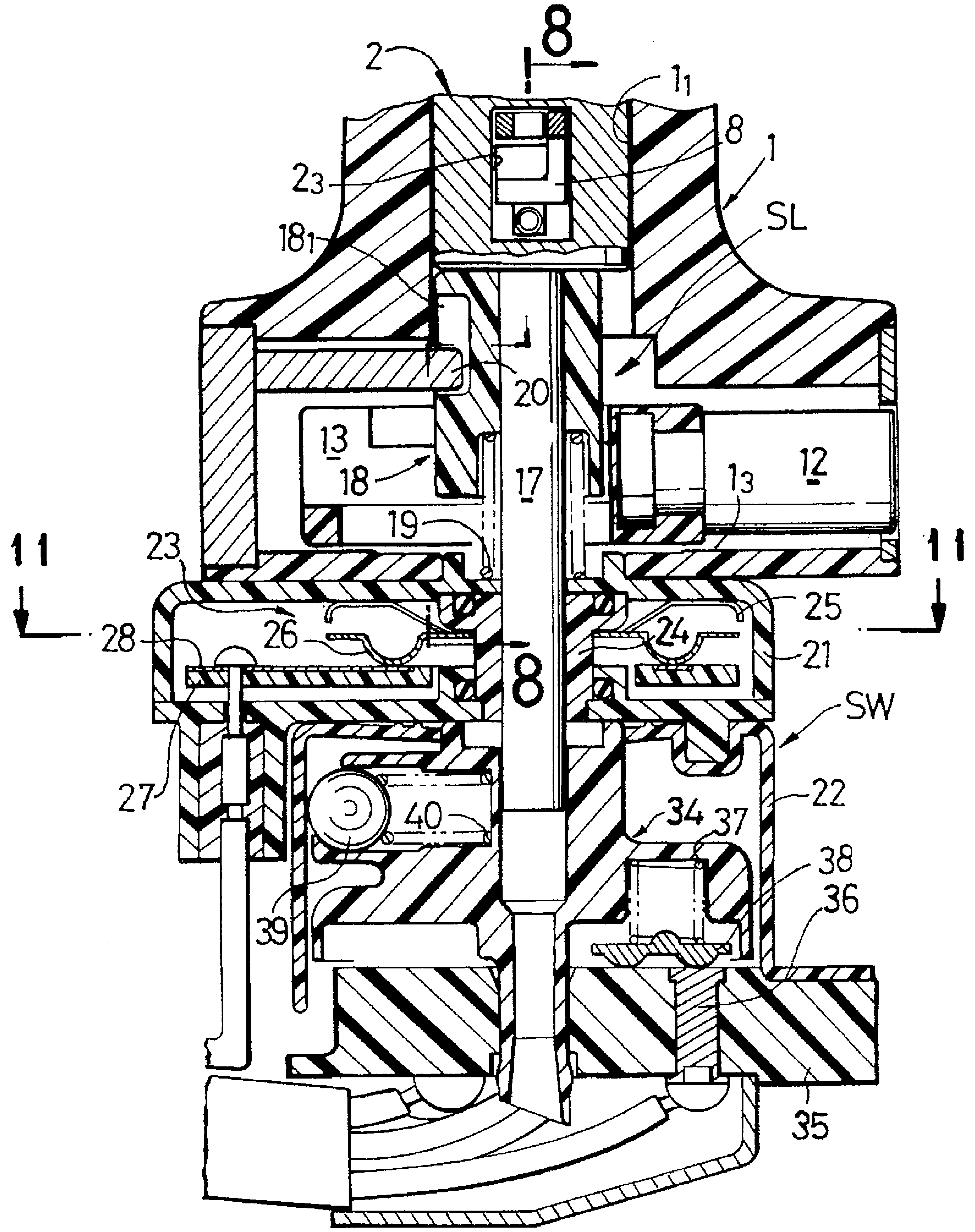

8
2
1₁
8
2₃
1
SL
18₁
20
13
12
18
17
1₃
19
11
23
11
25
28
26
24
21
8
SW
27
22
34
37
40
38
36
39
35

FIG. 8

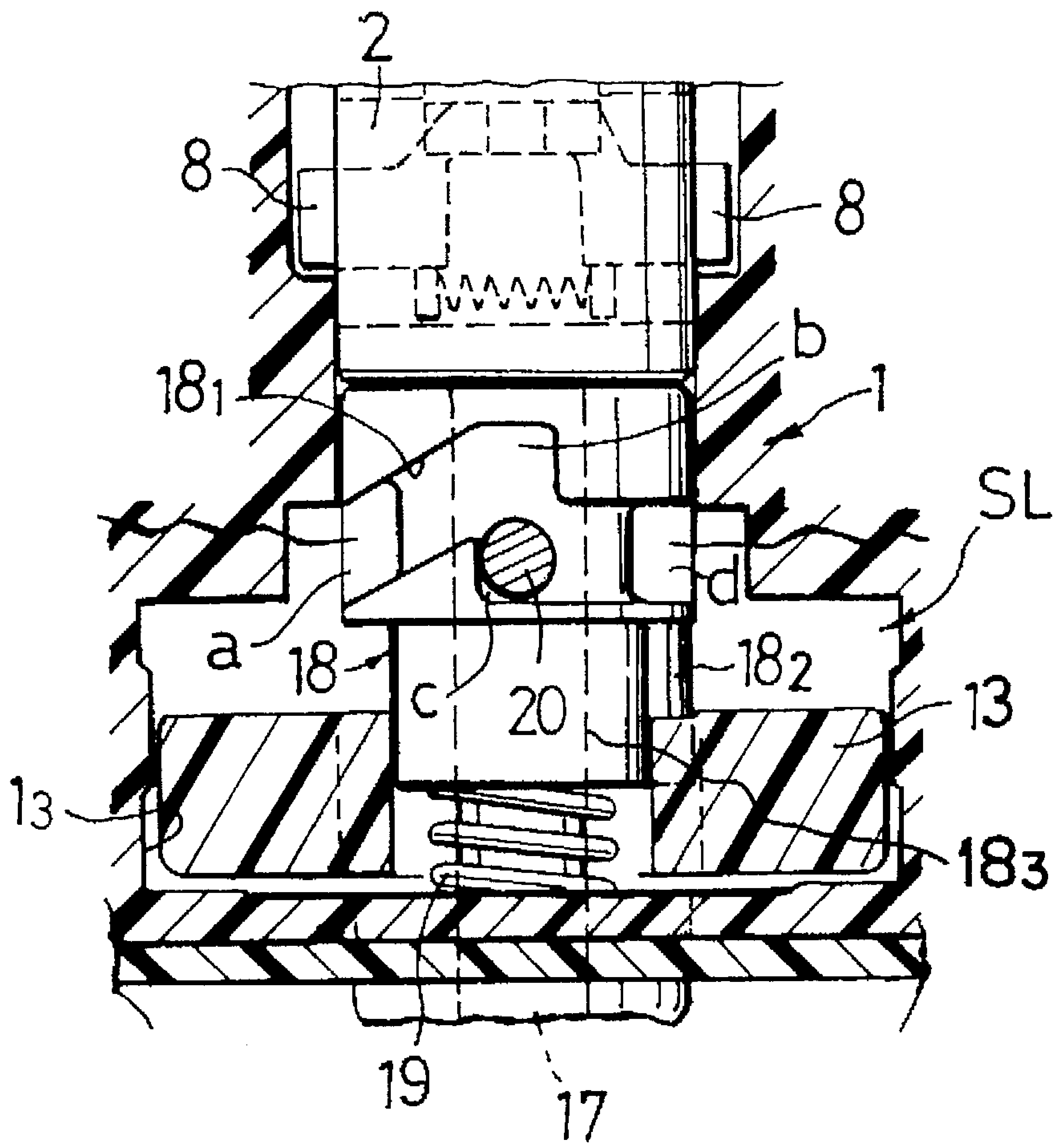


FIG.9

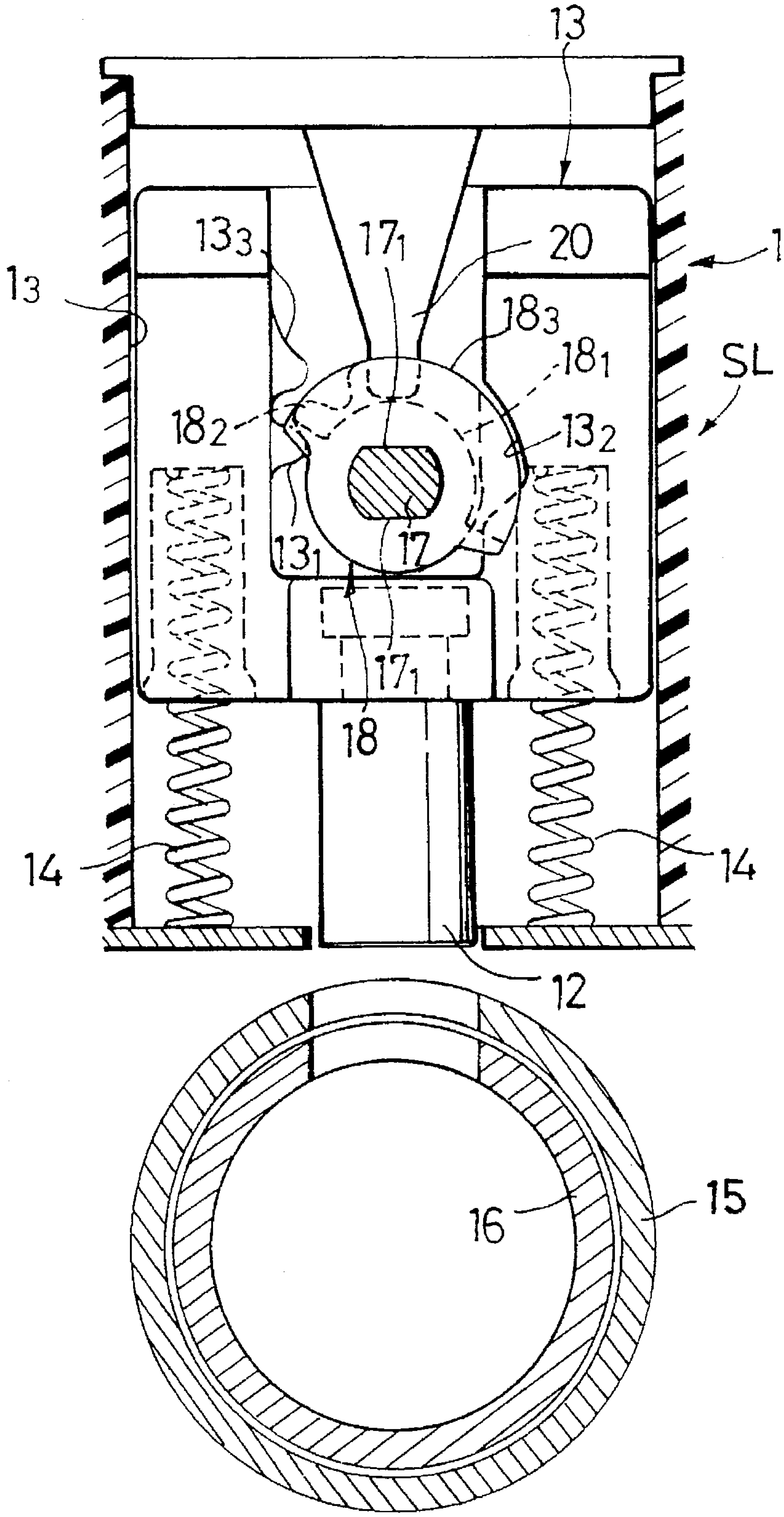


FIG. 10

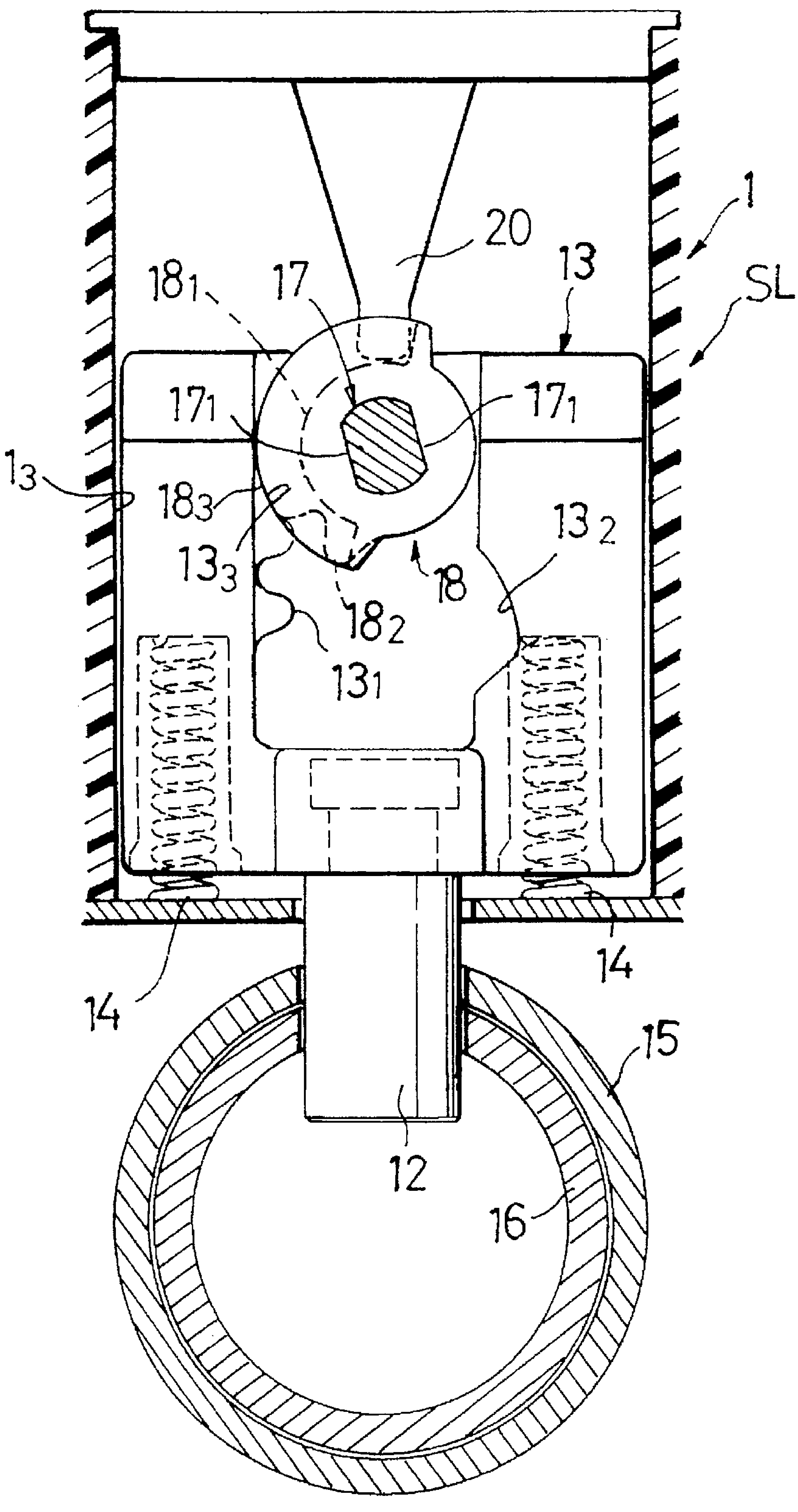


FIG. 11

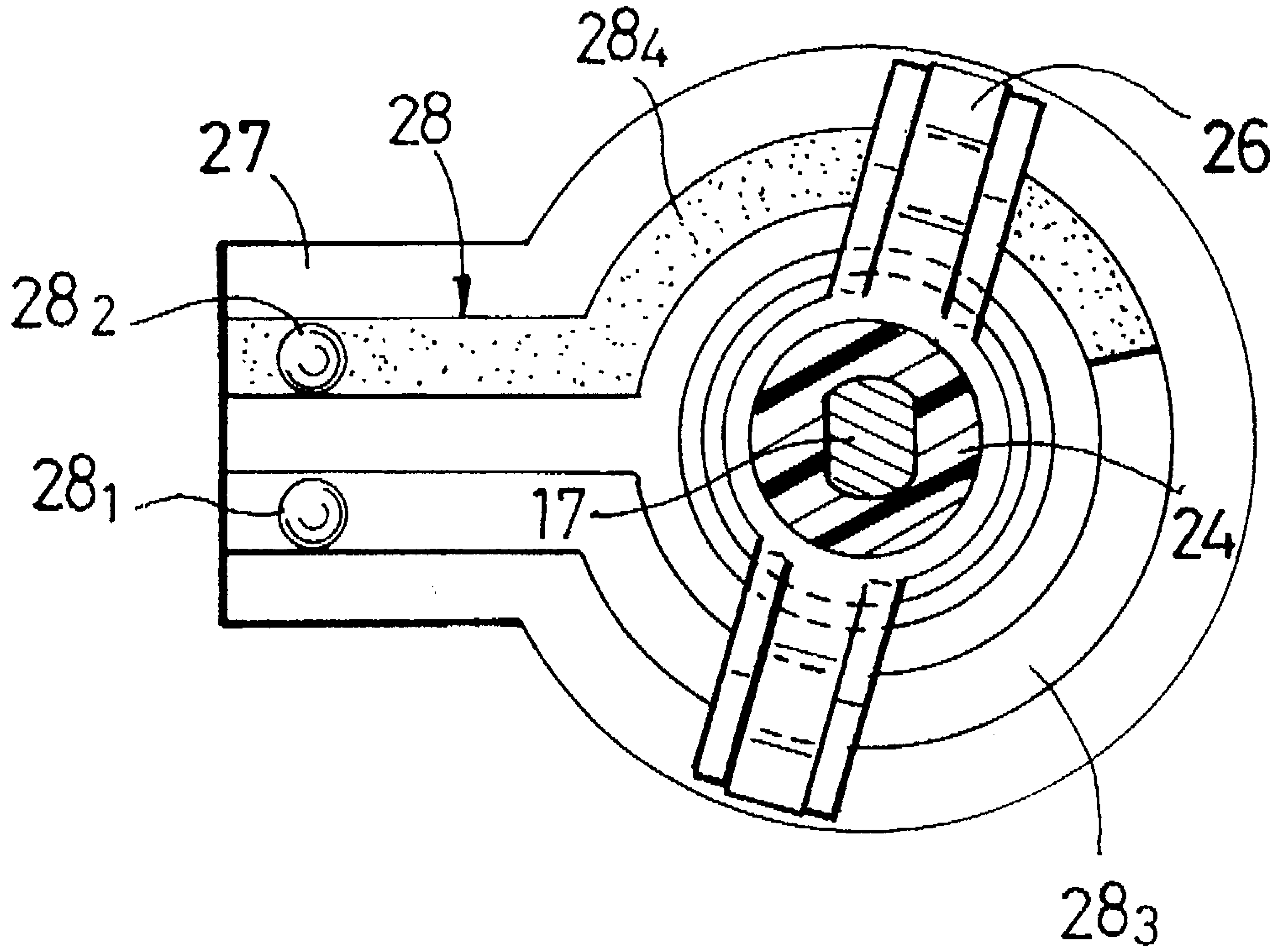


FIG.12

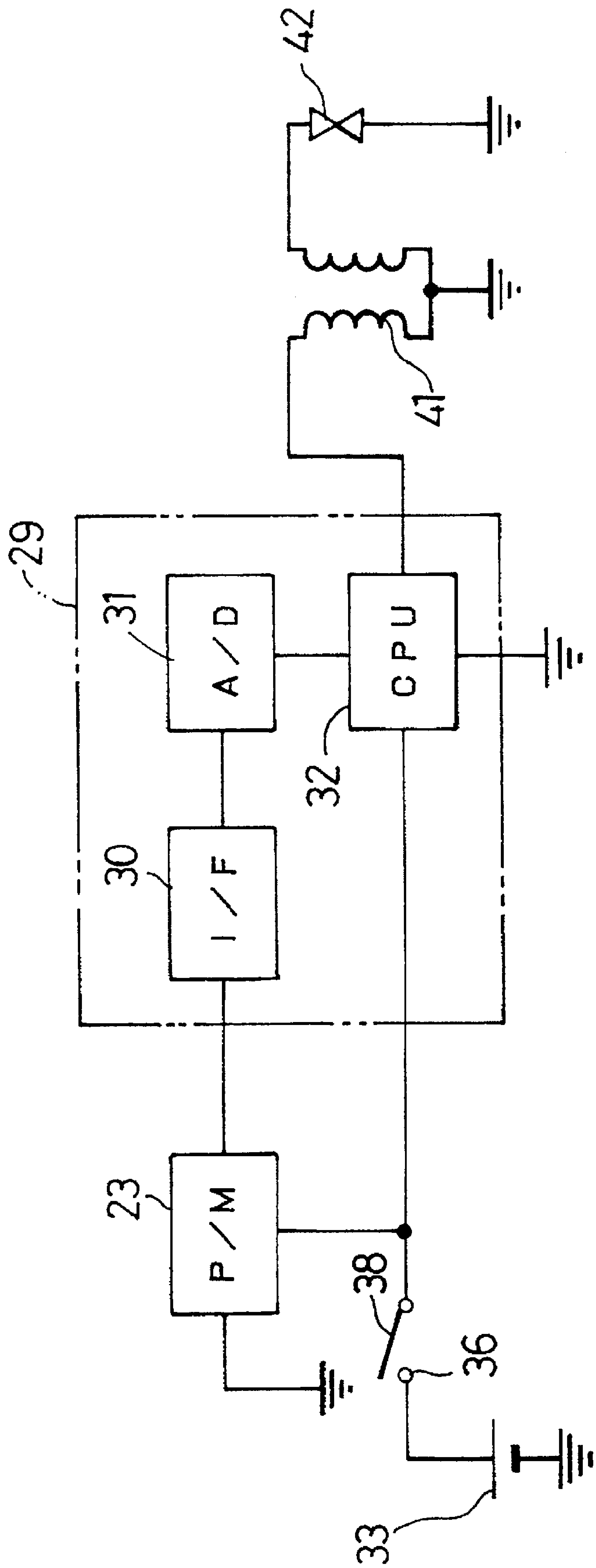


FIG. 13A

FIG. 13B

FIG. 13C

FIG. 13D

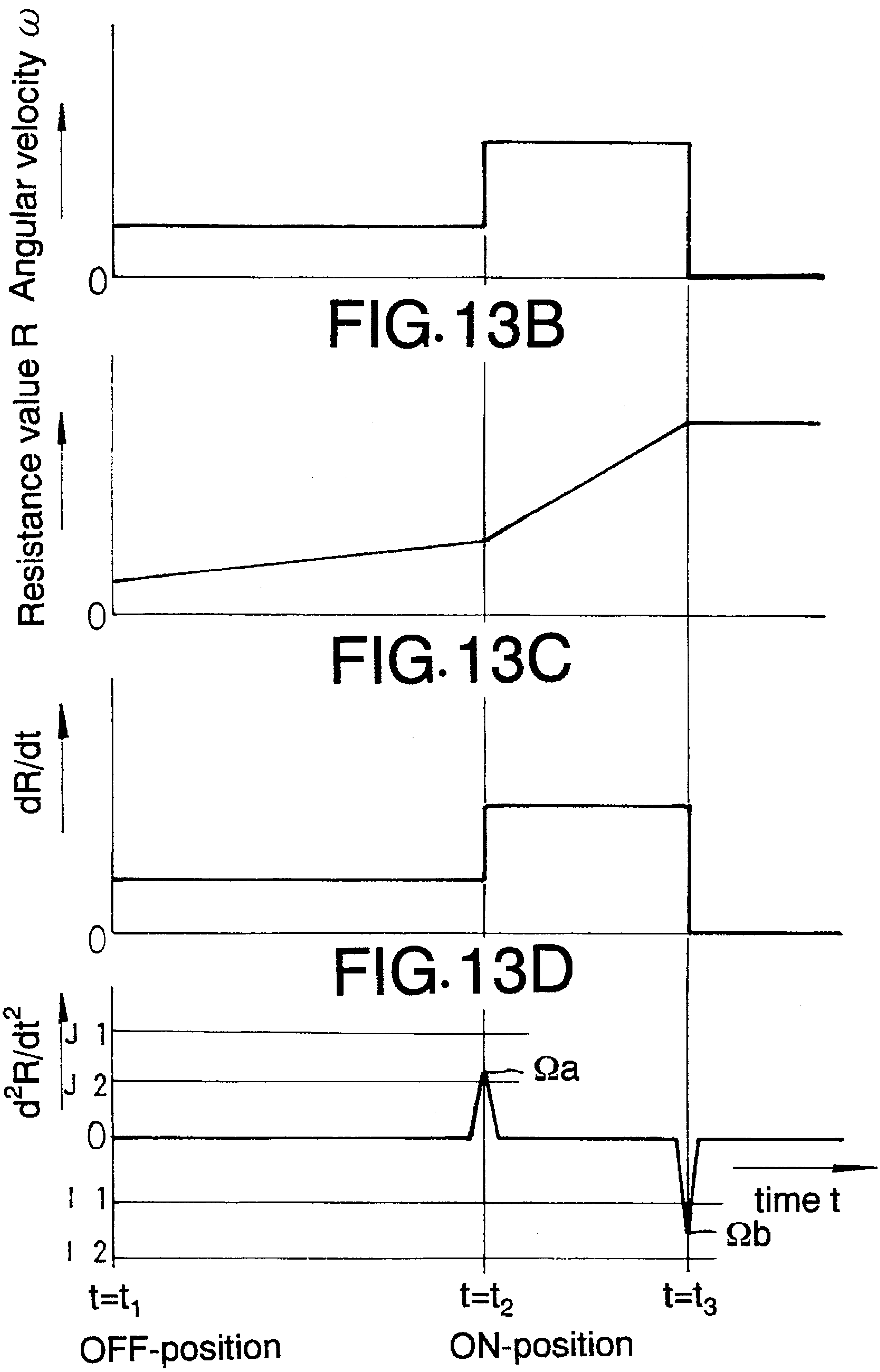


FIG. 14

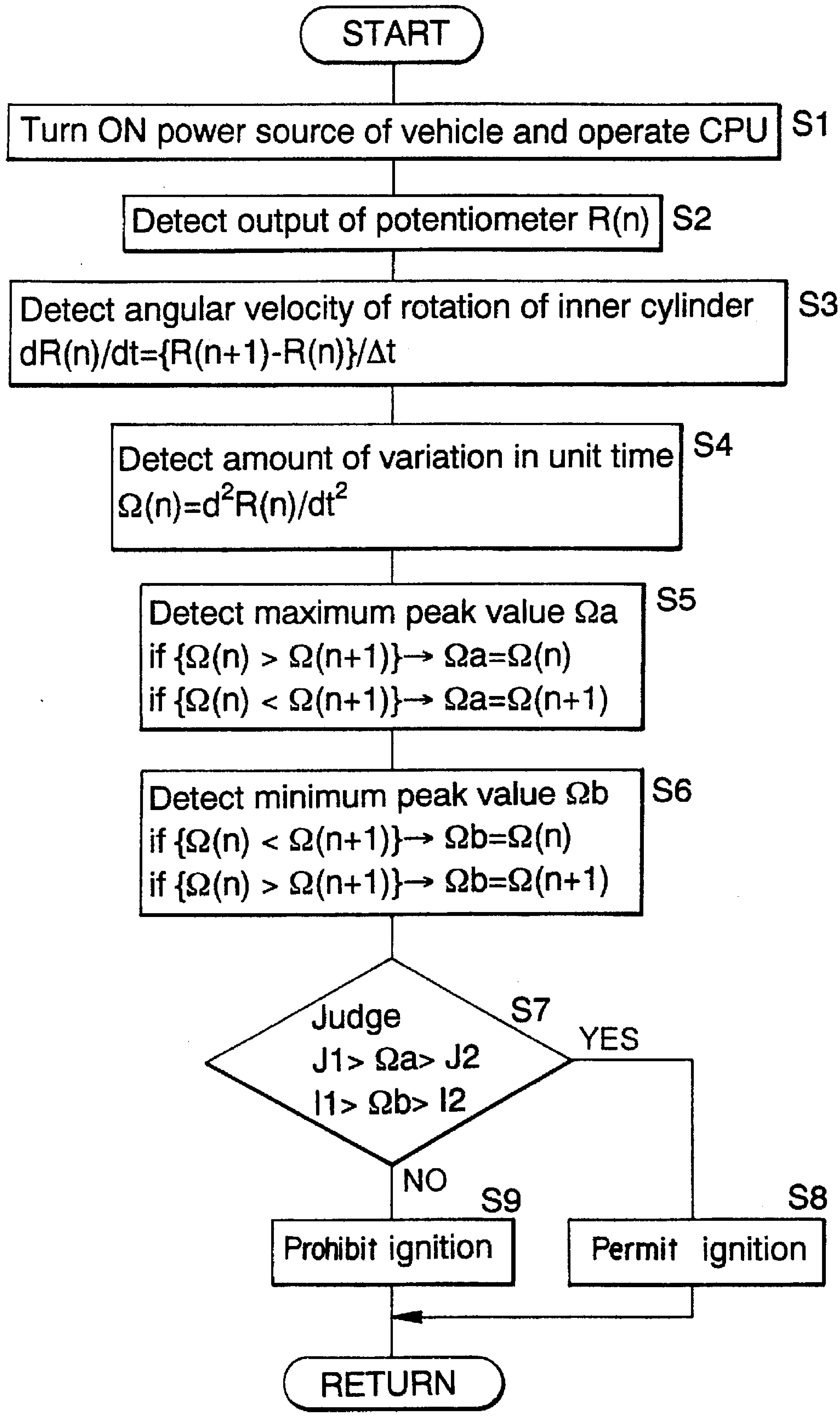
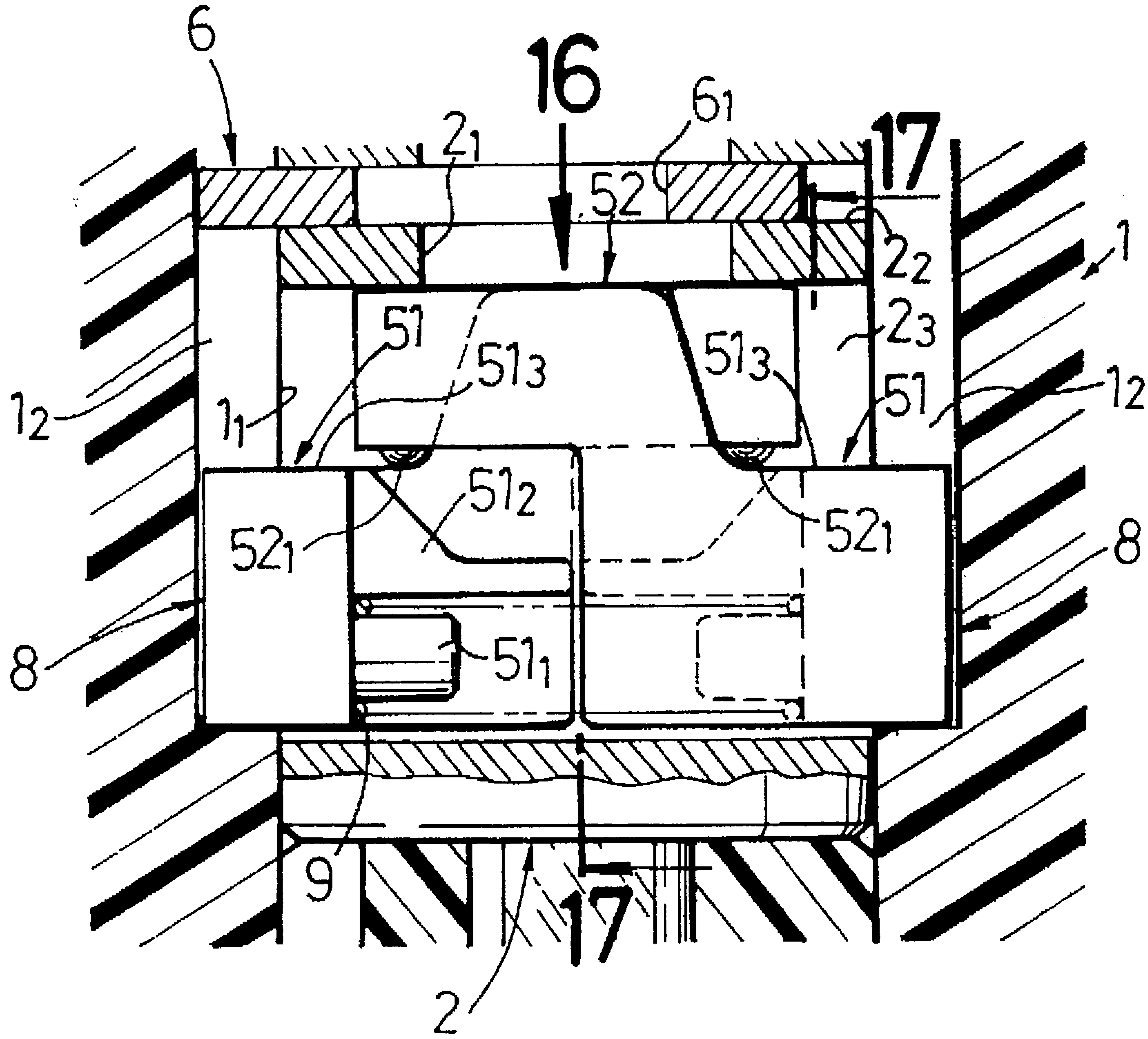
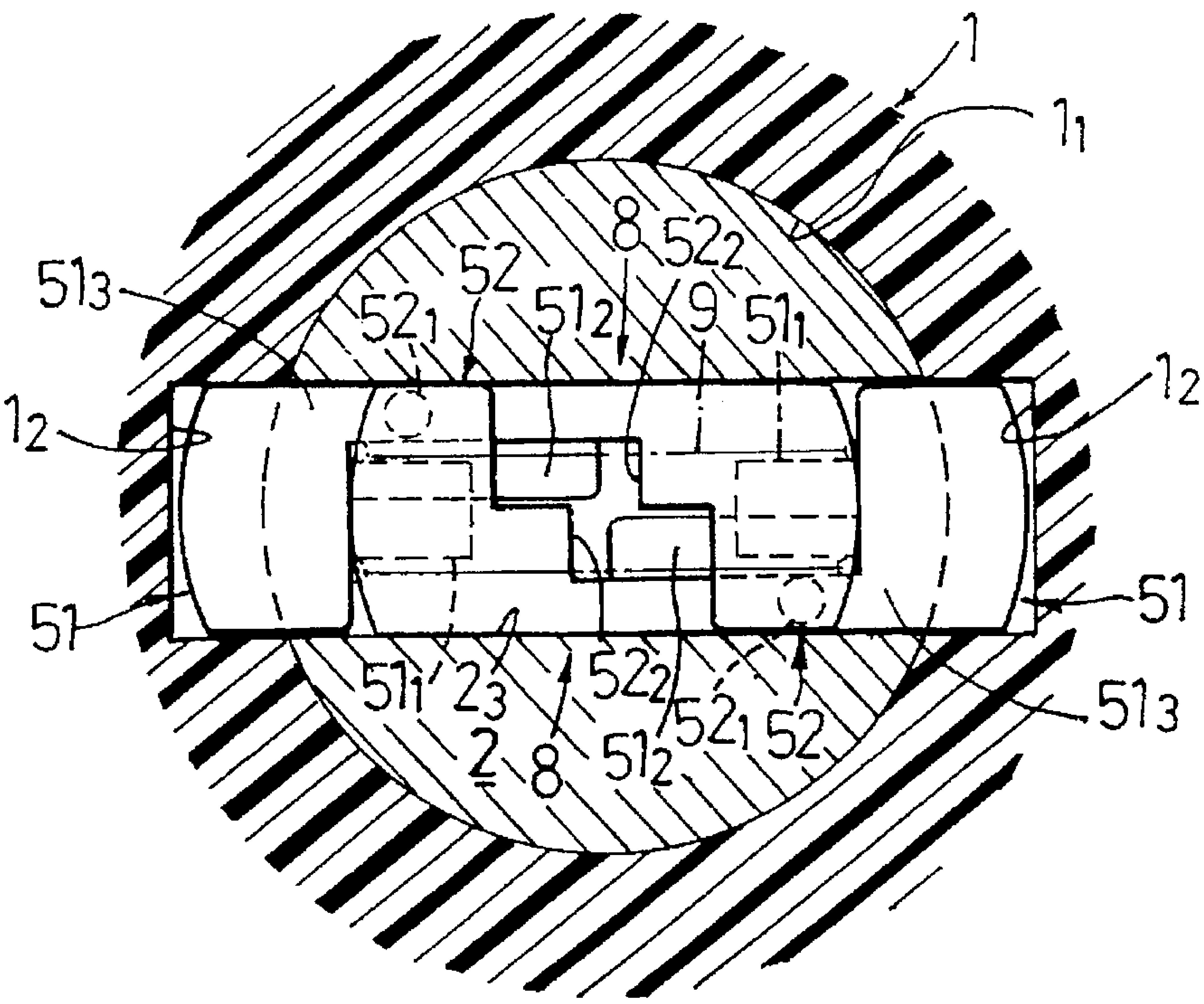

START
Turn ON power source of vehicle and operate CPU
S1
Detect output of potentiometer R(n)
S2
Detect angular velocity of rotation of inner cylinder
dR(n)/dt={R(n+1)-R(n)}/Δt
S3
Detect amount of variation in unit time
Ω(n)=d²R(n)/dt²
S4
Detect maximum peak value Ωa
if {Ω(n) > Ω(n+1)}→ Ωa=Ω(n)
if {Ω(n) < Ω(n+1)}→ Ωa=Ω(n+1)
S5
Detect minimum peak value Ωb
if {Ω(n) < Ω(n+1)}→ Ωb=Ω(n)
if {Ω(n) > Ω(n+1)}→ Ωb=Ω(n+1)
S6
Judge
J1> Ωa> J2
I1> Ωb> I2
S7
YES
NO
S9
Prohibit ignition
S8
Permit ignition
RETURN

FIG. 15


6
16
$6_1$
$2_1$
17
52
$2_2$
1
51
$51_3$
$51_3$
$2_3$
$1_2$
$1_1$
51
$1_2$
$52_1$
$51_2$
$52_1$
8
8
$51_1$
9
17
2

# FIG. 16A




# FIG. 16B

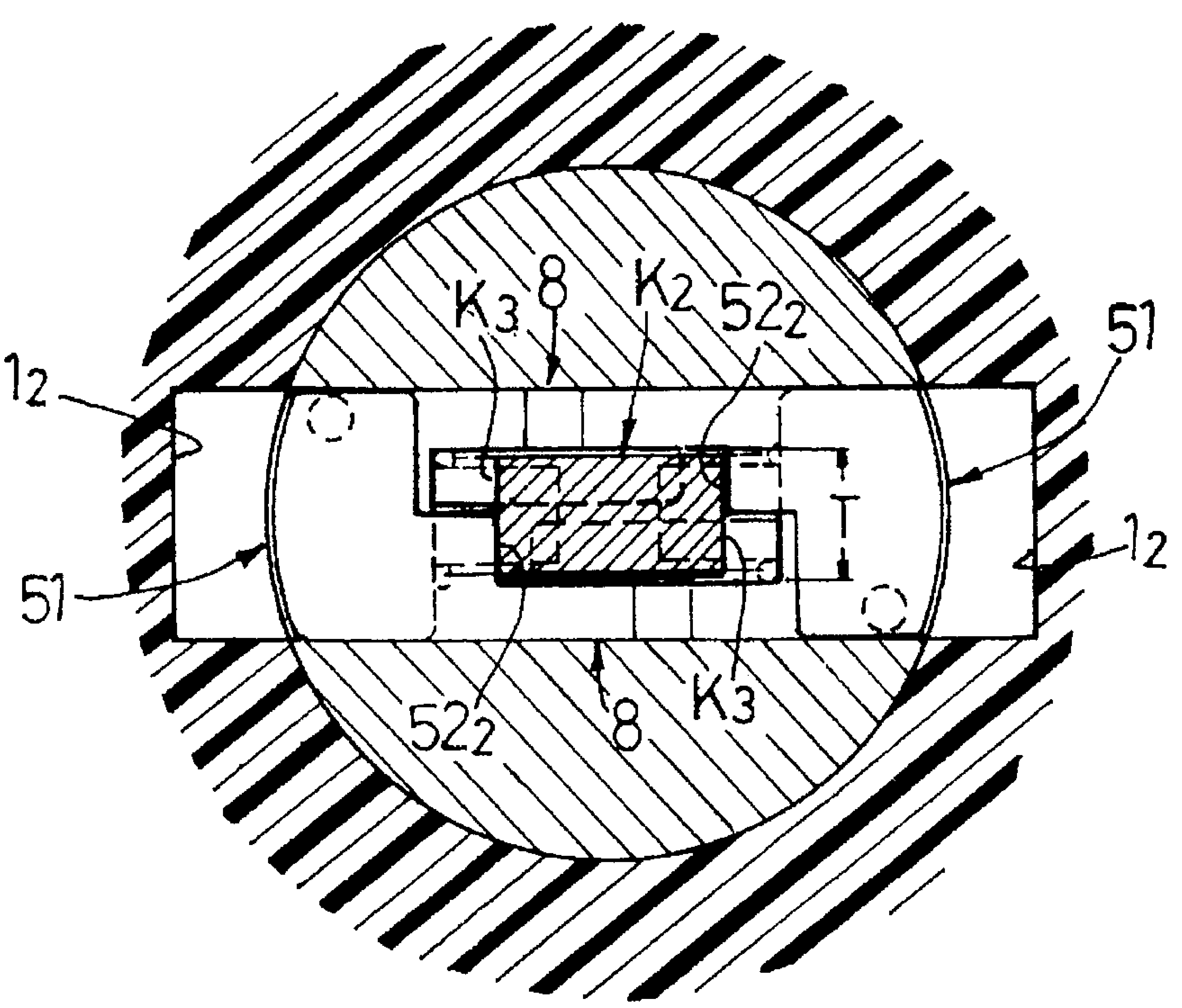


FIG. 17

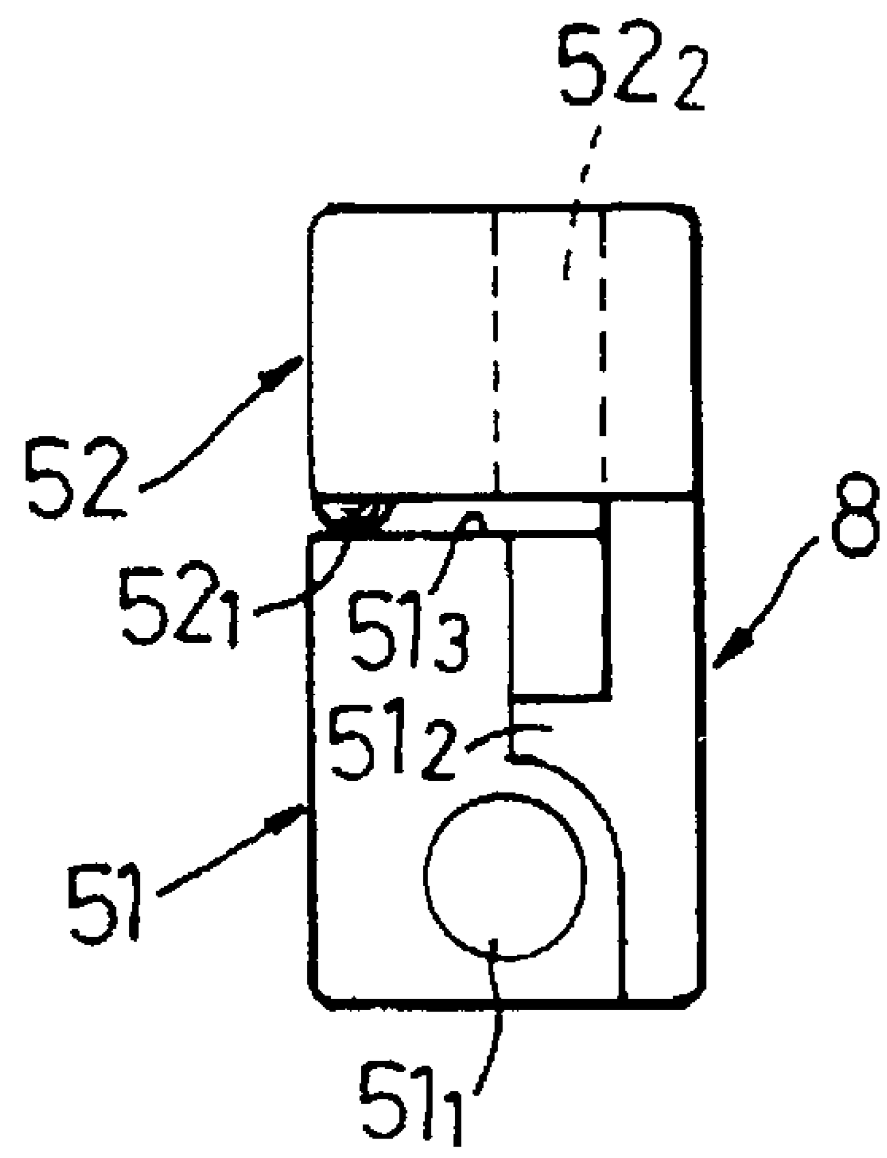

52₂
52
52₁
51₃
8
51₂
51
51₁

FIG. 18

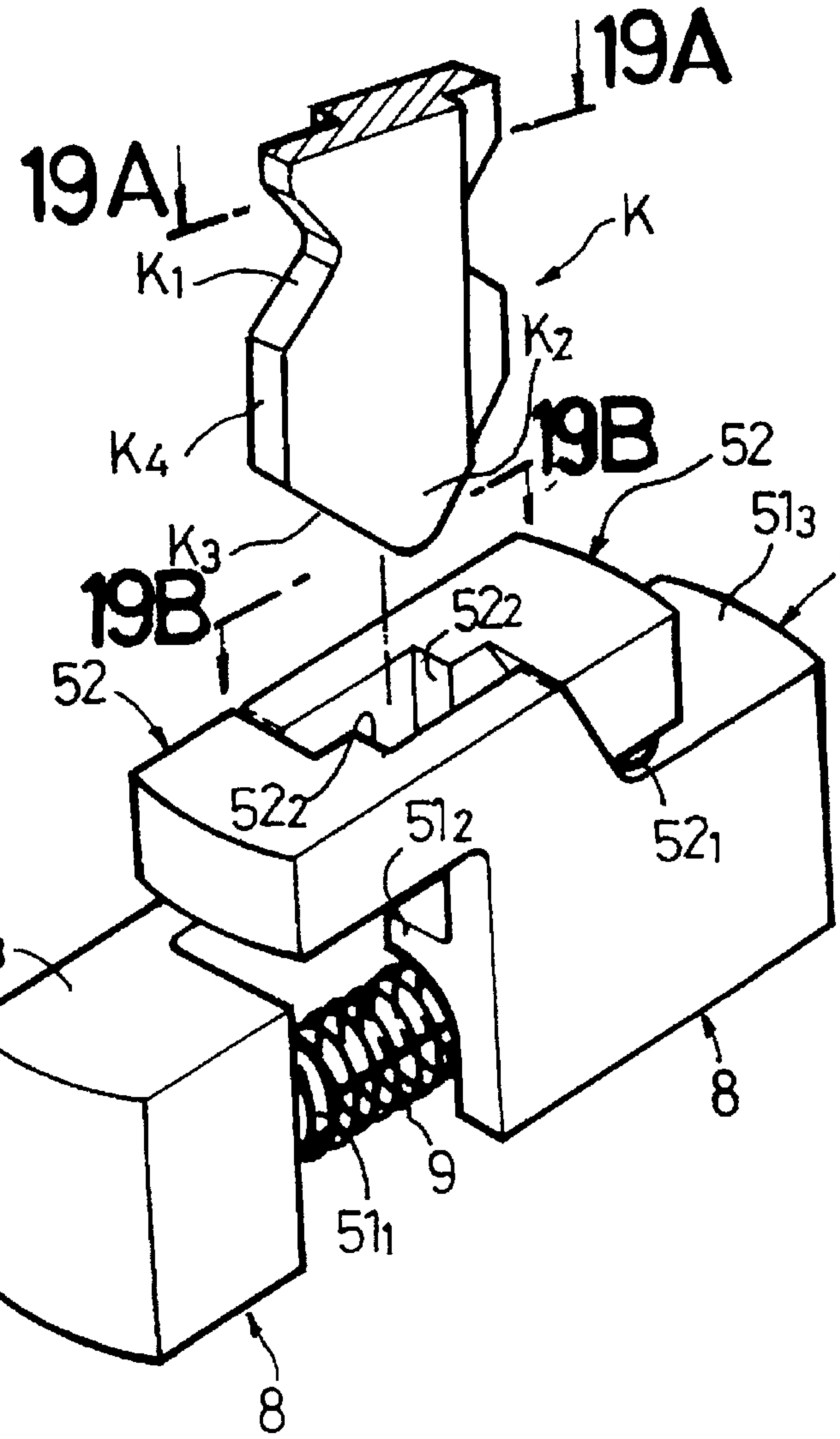

19A
19A
K
K1
K2
K4
19B
52
51₃
K3
51
19B
52₂
52
52₂
52₁
51₂
51₃
8
51
9
51₁
8

FIG. 19A

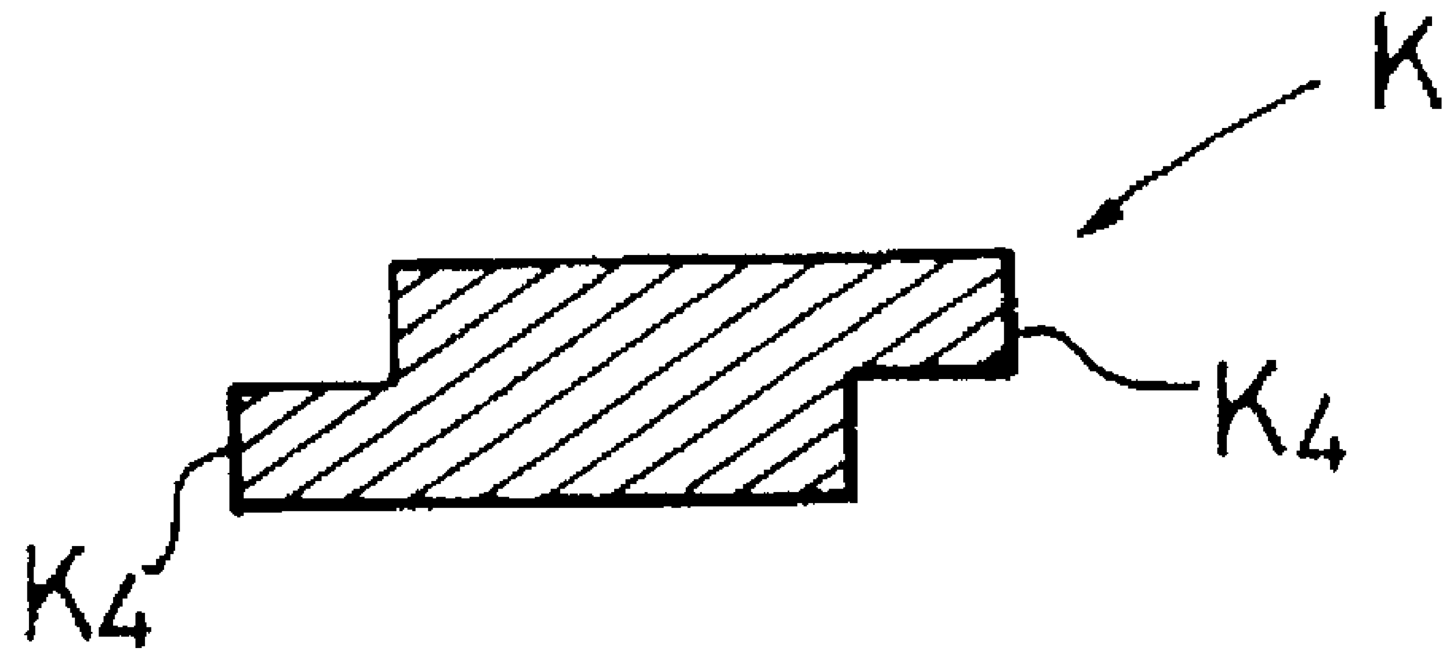
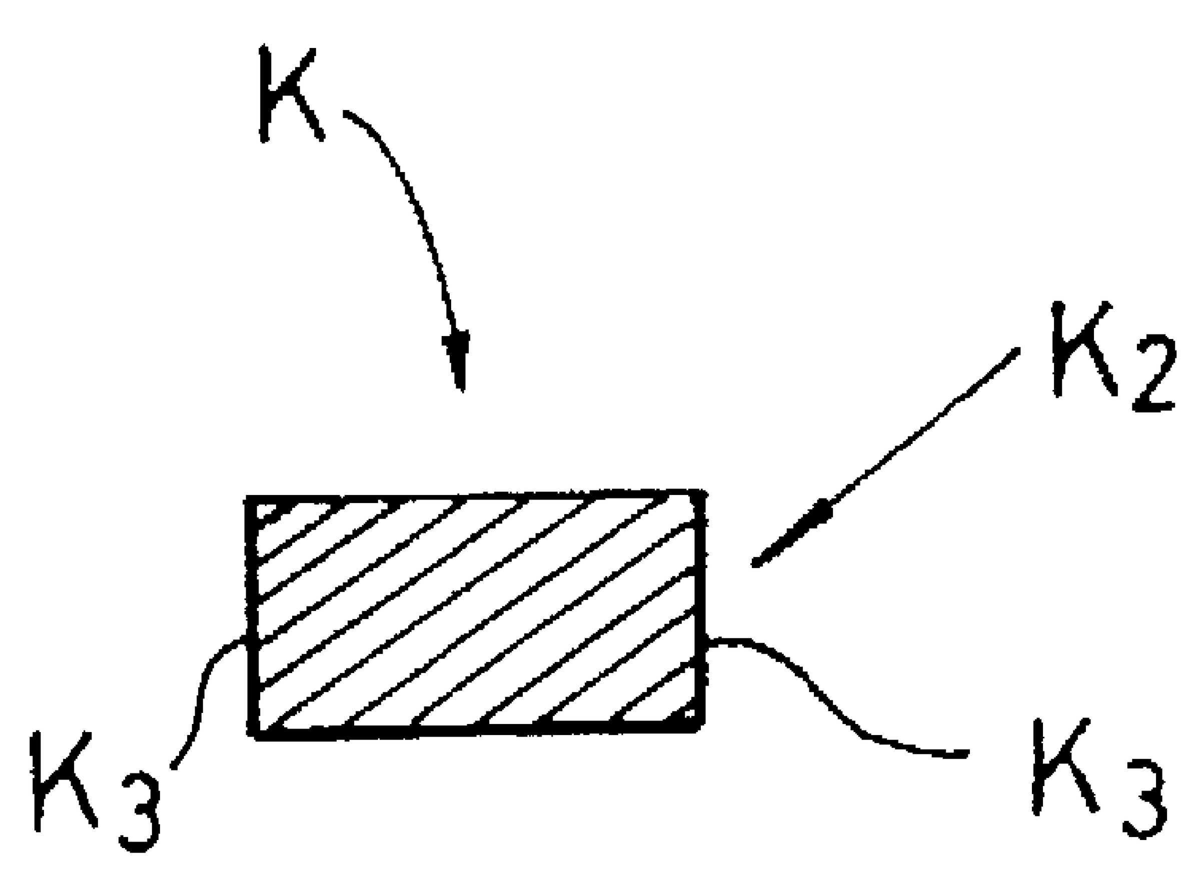



FIG. 19B



# KEY SWITCH SYSTEM FOR A VEHICLE

## FIELD OF THE INVENTION

The present invention relates to a key switch system for a vehicle, which is used in a motorcycle, an automotive vehicle or the like for operating a steering lock mechanism and a switch mechanism in operative association with the operation of a cylinder lock.

## DESCRIPTION OF THE PRIOR ART

Generally, a key switch system for the vehicle integrally includes a cylinder lock locked and dislocked by the operation of a key, a steering lock mechanism for locking a steering device in operative association with the operation of the cylinder lock, and a switch mechanism for turning ON an ignition circuit in operative association with the operation of the cylinder lock. In general, the cylinder lock includes an inner cylinder rotatably fitted in an outer cylinder. A plurality of tumblers are slidably supported in the inner cylinder to engage tumbler engagement grooves in the outer cylinder.

If a normal or predetermined key is inserted into a key hole in the inner cylinder, all the tumblers are retracted from the tumbler engagement grooves and hence, the inner cylinder can be turned by rotating the key to operate the steering lock mechanism and the switch mechanism. On the other hand, if a key other than the normal key is inserted, any of the tumblers is brought into engagement in the tumbler engagement groove. For this reason, even if the key is turned, the inner cylinder can not be turned and thus, the steering lock mechanism and the switch mechanism can not be operated.

The cylinder lock of the prior art key switch system for the vehicle inhibits the turning of the inner cylinder by engagement of the tumblers in the tumbler engagement grooves and moreover, the tumbler is formed of a plate-like member having a relatively low rigidity. For this reason, there is a problem that if a key other than the normal key is inserted and forcibly turned, the tumblers are damaged.

In order to eliminate such a disadvantage, a key switch system for a vehicle described in Japanese Utility Model Application Laid-open No. 108468/92 is designed such that if a key other than a normal key is inserted, an inner cylinder is axially pushed, whereby a control pin embedded in an outer cylinder is brought into engagement with a rotation arresting portion of a control groove provided in the inner cylinder. Thus, a rotational force of the inner cylinder can be received by the control pin to prevent a damage to the tumblers.

In the key switch system for the vehicle described in the above publication, the turning of the inner cylinder can be restricted by the control pin. However, the rigidity of the control pin is not necessarily sufficient, and it is desirable that a stronger rotation-restricting force is exhibited to prevent a damage to the tumblers.

## SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to reliably prevent a damage to the tumblers, when the key other than the normal key has been inserted and turned, or when the key has been shallowly inserted and turned.

To achieve the above object, according to the present invention, there is provided a key switch system for a vehicle, comprising: a cylinder lock comprised of an outer cylinder formed in its inner peripheral surface with axially-extending tumbler engagement grooves, an inner cylinder rotatably carried on the inner peripheral surface of the outer cylinder and having an axially extending key hole, and a plurality of tumblers radially slidably carried in the inner cylinder and capable of being engaged into tumbler engagement grooves in the outer cylinder and disengaged from the tumbler engagement grooves by the insertion of a key into the key hole; a steering lock mechanism operated in operative association with the rotation of the inner cylinder of the cylinder lock to lock a steering device; and a switch mechanism operated in operative association with the rotation of the inner cylinder of the cylinder lock to turn ON an ignition circuit; wherein the system further includes a cylinder pin which is radially slidably carried in the inner cylinder to engage the tumbler engagement groove in the outer cylinder and having a rigidity higher than that of the tumbler, and wherein the cylinder pin is disengaged from the tumbler engagement groove by abutment against a tip end of the key completely inserted into the key hole.

With the above construction, even if the key is forcibly turned in a state in which it is not completely inserted, or even if a different key is inserted and forcibly turned, a damage to the tumblers can be prevented by exhibiting a rotation-resisting force by the cylinder pin.

If a pair of the cylinder pins are radially slidably carried in the inner cylinder and biased away from each other by a spring to engage the different tumbler engagement grooves, the rotational force of the inner cylinder can be dispersed to the pair of cylinder pins and the tumbler engagement grooves, thereby exhibiting a larger rotation-resisting force.

If the cylinder pin includes a pin portion engaging the tumbler engagement grooves, an engage portion abutting against the tip end of the key, and a spring support portion for supporting a spring for biasing the pin portion in a direction to engage the tumbler engagement grooves, it is possible to insure the rigidity of the pin portion to prevent a reduction in rotation-resisting force.

If the steering lock mechanism includes a lock means advanced and retreated by the rotation of the inner cylinder to lock the steering device, and a cam means for moving the inner cylinder in an axial direction when the inner cylinder is turned between a locking position and a lock-releasing position, and if the cam means is axially disposed between the cylinder pin and the lock means, an increase in size of the key switch system due to the provision of the cylinder pins can be avoided by effectively utilizing a dead space between the cylinder pins and the lock means.

If the switch mechanism includes a potentiometer adapted to deliver a resistance value corresponding to the amount of rotation of the inner cylinder, and a control means adapted to turn ON an ignition circuit in response to the change in output from the potentiometer with time, the ignition circuit can be turned ON, only when the inner cylinder has been turned by a normal operation.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** to **14** illustrate a first embodiment of the present invention, wherein

FIG. **1** is a vertical sectional view of a key switch system for a vehicle;

FIG. **2** is an enlarged sectional view taken along a line **2**—**2** in FIG. **1**;

FIGS. **3**A and **3**B are enlarged sectional view taken along a line **3**—**3** in FIG. **1**;

FIG. **4** is a perspective view of a cylinder pin;

FIG. **5** is an enlarged sectional view taken along a line **5**—**5** in FIG. **11**;

FIG. 6A–6C are views for explaining the operation;

FIG. 7 is a sectional view taken along a line 7—7 in FIG. 1;

FIG. 8 is a sectional view taken along a line 8—8 in FIG. 7;

FIG. 9 is a sectional view taken along a line 9—9 in FIG. 1;

FIG. 10 is a view for explaining the operation;

FIG. 11 is a sectional view taken along a line 11—11 in FIG. 7;

FIG. 12 is a diagram of a control system;

FIGS. 13A–13D are graphs for explaining the operation;

FIG. 14 is a flow chart illustrating the operation;

FIGS. 15 to 19 illustrate a second embodiment of the present invention, wherein

FIG. 15 is a side view of a cylinder pin;

FIG. 16A and 16B are views taken along an arrow 16 in FIG. 15;

FIG. 17 is a view taken along a line 17—17 in FIG. 15;

FIG. 18 is a perspective view of the cylinder pin; and

FIGS. 19A and 19B are sectional views taken along a line 19A—19A and a line 19B—19B in FIG. 18, respectively.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

First, the structure of a cylinder lock L of a key switch system for a vehicle will be described with reference to FIGS. 1 to 6.

Referring to FIGS. 1 to 4, the cylinder lock L of the key switch system for the Vehicle includes an outer cylinder 1 having a cylinder bore $1_1$, an inner cylinder 2 axially slidably and relatively rotatably fitted in the cylinder bore $1_1$ in the outer cylinder 1, a cylinder crown 3 fitted in an upper end of the inner cylinder 2, a crown cover 4 which couples the inner cylinder 2 and the cylinder crown 3 to each other by caulking, and a cylinder cap 5 which closes an opening in an upper end of the outer cylinder 1 and has a key insertion opening $5_1$ into which a key K is inserted. The inner cylinder 2 and the cylinder crown 3 have key holes $2_1$ and $3_1$ axially defined therein, respectively, which are communicated with the key insertion opening $5_1$.

A pair of axially extending tumbler engagement grooves $1_2$, $1_2$ are defined in the cylinder bore $1_1$ in the outer cylinder 1, so that they are opposed to each other. On the other hand, seven tumbler slide grooves $2_2$ are defined parallel at predetermined axial distances in the inner cylinder 2 to radially extend therethrough. A tumbler 6 is slidably fitted in each of the tumbler slide grooves $2_2$ and is a substantially rectangular plate-like member, whose opposite ends are engageable into the pair of tumbler engagement grooves $1_2$, $1_2$ in the outer cylinder 1. The number of the tumblers 6 is not limited to seven, and optimally, it is desirable that eight tumblers 6 are provided. When the key K is not inserted into the key hole $2_1$ in the inner cylinder 2, each of the tumblers 6 is biased in one direction by the action of corresponding one of springs 7 (see FIG. 2) and is engaged at one end thereof into the tumbler engagement groove $1_2$ to restrict the rotation of the inner cylinder 2.

A code hole $6_1$ of a predetermined shape is defined in each of the tumblers 6 in line with the key hole $2_1$ in the inner cylinder 2. When a normal key K is inserted into the key holes $2_1$ and $3_1$ through the key insertion opening $5_1$ to reach a predetermined position, code valleys $K_1$ recessedly provided in opposite edges of the key K are engaged into the code holes $6_1$ in the tumblers 6. As a result, the tumblers 6 are slid radially within the tumbler slide grooves $2_2$, so that the opposite ends thereof are disengaged from the tumbler engagement grooves $1_2$, $1_2$. That is, the opposite ends of the tumblers 6 are retracted inwardly from an outer peripheral surface of the inner cylinder 2.



When a key different from the normal key K has been inserted, the rotation of the inner cylinder 2 is restricted by the engagement of the ends of at least one of the tumblers 6 into the tumbler engagement grooves $1_2$, $1_2$.

A pair of left and right cylinder pins 8, 8 for restricting the rotation of the inner cylinder 2 by cooperation with the tumblers 6 are radially slidably carried in a cylinder pin slide groove $2_3$ formed in the inner cylinder 2 to lie below the seven tumblers 6. The cylinder pin 8 includes a pin portion $8_1$ having a rectangular section and engageable into the tumbler engagement groove $1_2$ in the outer cylinder 1, an engage portion $8_2$ capable of abutting against a tip end $K_2$ of the key K, and a spring support portion $8_3$ for supporting one of opposite ends of a spring 9 for biasing both the cylinder pins 8, 8 in a direction away from each other, i.e., in a direction of engagement of the pin portions $8_1$ into the tumbler engagement grooves $1_2$, $1_2$.

Therefore, when the key K is not inserted, the pin portions $8_1$, $8_1$ are in engagement with the tumbler engagement grooves $1_2$, $1_2$ under a resilient force of the spring 9 to restrict the rotation of the inner cylinder 2. When the normal key K has been inserted deeply into the key holes $2_1$ and $3_1$, the engage portions $8_2$, $8_2$ are pushed and opened by the tip end $K_2$ of the key K, thereby causing the pin portions $8_1$, $8_1$ to be disengaged from the tumbler engagement grooves $1_2$, $1_2$ against the resilient force of the spring 9 to permit the rotation of the inner cylinder 2.

When the normal key K has been inserted deeply into the key holes $2_1$ and $3_1$ as described above, the tumblers 6 and the cylinder pins 8, 8 are retracted into the inner cylinder 2 and disengaged from the tumbler engagement grooves $1_2$, $1_2$ in the outer cylinder 1, so that the inner cylinder 2 can be turned by turning the key K. On the other hand, if the key K has been turned in a state in which it is not correctly inserted deeply into the key holes $2_1$ and $3_1$, the rotation of the inner cylinder 2 is restricted, because any of the tumblers 6 and the cylinder pins 8, 8 are in engagement with the tumbler engagement grooves $1_2$, $1_2$.

At that time, a key-turning force is transmitted through the tumblers 6 and the cylinder pins 8, 8 to the outer cylinder 1. However, the rigidity of the block-like cylinder pins 8, 8 is far high, as compared with the rigidity of the plate-like tumblers 6 and hence, the key-turning force is received mainly by the cylinder pins 8, 8, thereby preventing the rotation of the inner cylinder 2 and the damage to the tumblers 6. Therefore, even if the inner cylinder 2 is intended to be accidentally forcibly turned, the cylinder pins 8, 8 having the high rigidity resist to prevent the rotation of the inner cylinder 2 and the damage to the tumblers 6.

By formation of the engage portions $8_2$, $8_2$ and the spring abutment portions $8_3$, $8_3$ with respect to the pin portion as $8_1$, $8_1$ of the cylinder pins 8, 8, the rigidity of the pin portions $8_1$, $8_1$ can sufficiently be insured to exhibit a large rotation-restricting force. Further, it is possible to further increase the rotation-restricting force by the engagement of the two cylinder pins 8, 8 in the different tumbler engagement grooves $1_2$, $1_2$.

As can be seen from both of FIGS. 5 and 6, a shutter mechanism SH for opening and closing the key hole $3_1$ is provided within the cylinder crown 3. The shutter mechanism SH includes a pair of shutter members **10**, **10** formed into a substantially triangular prism shape. Guide pins $\mathbf{10}_1$ are projectingly provided on opposite ends of each of the shutter members **10**, **10** and slidably carried on recessed guide surfaces $\mathbf{3}_2$ formed on the cylinder crown **3**. A pair of leaf springs **11**, **11** are fixed to an upper surface of the cylinder crown **3** and have tongue pieces $\mathbf{11}_1$, $\mathbf{11}_1$ which abut against the shutter members **10**, **10** to bias them toward each other.

As shown in FIGS. **5** and **6**A, the pair of shutter members **10**, **10** are normally in abutment against each other to cut communication of the key insertion opening $\mathbf{5}_1$ in the cylinder cap **5** with the key hole $\mathbf{3}_1$. If the tip end $K_2$ of the key K has been inserted from this state into the key insertion opening $\mathbf{5}_1$, the pair of shutter members **10**, **10** which have the guide pins $\mathbf{10}_1$ guided on the guide surfaces $\mathbf{3}_2$ are moved away from each other while being turned, thereby permitting the tip end $K_2$ of the key K to be introduced into the key hole $\mathbf{3}_1$, as shown in FIGS. **6**B and **6**C.

In this way, the shutter members **10**, **10** for closing the key hole $\mathbf{3}_1$ are provided as two members and therefore, it is possible to reduce the amount of movement of each of the shutter members **10**, **10** to provide a reduction in size of the shutter mechanism SH, as compared with a conventional system using a single shutter member. In addition, the triangular prism-shaped shutter members **10**, **10** are moved while being turned with the insertion of the key K and therefore, the tip end $K_2$ of the key K can be guided smoothly. Further, as can be seen from the comparison of FIGS. **6**A and **6**C, a space for insertion of the key K can be defined by rotating the shutter members **10**, 10 through 90°, while minimizing the amount of movement of the shutter members **10**, **10**. This makes it possible to further reduce the size of the shutter mechanism SH.

If the key K is withdrawn, the shutter members **10**, **10** are further turned through 30° from a state shown in FIG. **6**C to a state shown in FIG. **6**A. Therefore, every time when the key is inserted, the triangular prism-shaped shutter members **10**, **10** are turned through 120° each, so that three outer surfaces constituting the triangular prism alternately close the key hole $\mathbf{3}_1$.

The structure of a steering lock mechanism SL of the key switch for the vehicle will be described below with reference to FIG. **1** and FIGS. **7** to **10**.

A slider **13** is slidably fitted in a slider slide groove $\mathbf{1}_3$ provided at a lower portion of the outer cylinder **1**, and has a lock pin extending rearwardly of the vehicle. If the slider **13** is retreated while compressing a pair of springs **14**, **14** with the rotation of the inner cylinder **2**, a protruding lock pin **12** is fitted into a head pipe **15** and a steering shaft **16** in the motorcycle, thereby locking a steering device.

The inner cylinder **2** and the slider **13** are interconnected in a following manner. A cylinder shaft **17** having a diameter smaller than that of the inner cylinder **2** is formed coaxially and integrally at a lower portion of the inner cylinder **2**. Chamfers $\mathbf{17}_1$, $\mathbf{17}_1$ are provided around an outer periphery of the cylinder shaft **17** (see FIG. **9** and **10**), and a cylinder guide body **18** is relatively non-rotatably and axially movably fitted over the cylinder shaft **17**. The cylinder guide body **18** is biased upwardly by a spring **19** to abut against a lower surface of the inner cylinder **2**.

The cylinder guide body **18** has an angled cam groove $\mathbf{18}_1$ provided in a front surface thereof, and a guide pin **20** is fitted in the cam groove $\mathbf{18}_1$ and fixed in a rearwardly turned attitude to the outer cylinder **1**. Thus, when the inner cylinder **2** is turned, the cylinder guide body **18** is turned in unison with the inner cylinder **2** and the cam groove $\mathbf{18}_1$ is guided by the fixed guide pin **20**, thereby causing the cylinder guide body **18** to be axially moved along with the inner cylinder **2**.

This will be described in detail with reference to FIG. **8**. When the inner cylinder **2** is in a locking position which is an end of movement in a counterclockwise direction, the guide pin **20** is in a fitted state at a position a in the cam groove $\mathbf{18}_1$ in the cylinder guide body **18**. When the inner cylinder **2** is turned from this state in a clockwise direction using the key K, the cylinder guide body **18** with the cam groove $\mathbf{18}_1$ guided by the guide pin **20** is lowered against a resilient force of the spring **19**. When the guide pin **20** has reached a position b in the cam groove $\mathbf{18}_1$, the cylinder guide body **18** is lifted by the resilient force of the spring **19** into an OFF-position in which the guide pin **20** is fitted in a position c in the cam groove $\mathbf{18}_1$. When the inner cylinder **2** is further turned from this state in the clockwise direction, the guide pin **20** is fitted into a position d in the cam groove $\mathbf{18}_1$ to assume an ON-position which is an end of rotation of the inner cylinder **2** in the clockwise direction.

On the other hand, when the inner cylinder **2** is turned in the counterclockwise direction from the ON-position which is the end of turning movement of the inner cylinder in the clockwise direction, the guide pin **20** is moved from the position d to the position c to assume the OFF-position. To turn the inner cylinder **2** into the locking position which is an end of turning movement in the counterclockwise direction, the key K may be urged axially to force the inner cylinder **2** and the cylinder guide body **18** against the resilient force of the spring **19**, thereby moving the guide pin **20** from the position c to the position b in the cam groove $\mathbf{18}_1$, and then, the inner cylinder may be turned in the counterclockwise direction to move the guide pin **20** to the position a in the cam groove $\mathbf{18}_1$.

The cylinder guide body **18** has a driving projection $\mathbf{18}_2$ and a locking camsurface $\mathbf{18}_3$ formed thereon at a location lower than the cam groove $\mathbf{18}_1$ by one step. The slider **13** includes a follower projection $\mathbf{13}_1$ which is engaged by the projection $\mathbf{18}_2$, and a first and a second locked cam surface $\mathbf{13}_2$ and $\mathbf{13}_3$ which are engaged by the locking cam surface $\mathbf{18}_3$.

As can be seen from FIG. **9**, when the cylinder guide body **18** is turned from the ON-position in the counterclockwise direction to reach the shown OFF-position, the driving projection $\mathbf{18}_2$ of the cylinder guide body **18** is brought into engagement with the follower projection $\mathbf{13}_1$ of the slider **13**. When the cylinder guide body **18** is further turned from the OFF-position to the locking position shown in FIG. **10** in the counterclockwise direction, the slider **13** with the follower projection $\mathbf{13}_1$ urged by the driving projection $\mathbf{18}_2$ is slid rearwardly, thereby causing the lock pin **12** to be fitted into the head pipe **15** and the steering shaft **16** to operate a steering lock. During that time, the slider **13** is maintained at a rearward slid position shown in FIG. **10** by engagement of the locking cam surface $\mathbf{18}_3$ with the second locked cam surface $\mathbf{13}_3$ of the slider **13**.

Conversely, when the cylinder guide body **18** is turned from the locking position toward the OFF-position in the clockwise direction, the lock pin **12** is moved away from the head pipe **15** and the steering shaft **16** to dislock the steering lock by advancing movement of the slider **13** by the resilient force of the springs **14**, **14**. During that time, the slider **13** is maintained at a forwardly slid position shown in FIG. **9** by engagement of the locking cam surface $\mathbf{18}_3$ of the cylinder guide body **18** with the first locked cam surface $\mathbf{13}_2$ of the slide **13**. The engagement of the locking cam surface $18_3$ of the cylinder guide body **18** with the first locked cam surface $13_2$ of the slider **13** is continued until the cylinder guide body **18** is turned to the ON-position.

As described above, the slider **13** is slid by the engagement of the driving projection $18_2$ of the cylinder guide body **18** with the follower projection $13_1$ of the slider **13**, and stopped by the engagement of the locking cam surface $18_3$ of the cylinder guide body **18** with the first locked cam surface $13_2$ and the second locked cam surface $13_3$ of the slider **13**. Therefore, the slider **13** can be reliably slid and stopped in a compact structure. Moreover, since the cylinder pins **8**, **8** are disposed at locations corresponding to those in which cam means has been provided in the prior art for axially moving the inner cylinder **2** in response to the rotation of the inner cylinder **2**, and the guide pin **20** and the cam groove $18_1$ as the cam means are disposed at locations corresponding to those which have been a dead space in the prior art, it is possible to provide a reduction in size of the key switch for the vehicle, despite the provision of the guide pins **8**, **8** to increase the rotation restricting force for the inner cylinder **2**.

The structure of a switch mechanism SW of the key switch for the vehicle will be described below with reference to FIG. **7** and FIGS. **11** to **14**.

As shown in FIG. **7**, the switch mechanism SW is connected to a lower portion of the steering lock mechanism SL, and includes a potentiometer housing **21** and a switch housing **22** through which the cylinder shaft **17** extending downwardly from the inner cylinder **2** is inserted. A potentiometer **23** accommodated within the potentiometer housing **21** includes a boss **24** relatively non-rotatably and axially slidably fitted over the cylinder shaft **17**, a movable contact **26** secured to the boss **24** and biased downwardly by a spring **25**, a stationary contact holder **27** fixed within the potentiometer housing **21**, and a stationary contact **28** which is formed on an upper surface of the stationary contact holder **27** and with which the movable contact **26** comes into sliding contact.

As can be seen from FIG. **11**, the stationary contact **28** is formed into a substantially annular shape and has terminals $28_1$ and $28_2$ at opposite ends thereof. One of halves of the stationary contact **28** is formed of a conductor $28_3$, and the other half is formed of an electric resistor $28_4$. The opposite ends of the movable contact **26** are in contact with the conductor $28_3$ and the electric resistor $28_4$ of the stationary contact **28** respectively, so that the electric resistance value between both the terminals $28_1$ and $28_2$ is varied when the movable contact **26** is turned with the rotation of the inner cylinder **2**.

Returning to FIG. **7**, a movable contact **38** is mounted in a movable contact holder **34** which is accommodated within the switch housing **22** and relatively non-rotatably and axially movably fitted over a lower end of the cylinder shaft **17**. The movable contact is biased by a spring **37** in a direction to abut against a stationary contact **36** mounted in a stationary contact holder **35**. A click ball **39** is radially movably mounted in the movable contact holder **35** and biased toward an inner peripheral surface of the switch housing **22** by a spring **40**. Three recesses (not shown) are provided on the inner peripheral surface of the switch housing **22** to correspond to the three positions, i.e., the locking position, the OFF-position and the ON-position. Thus, the inner cylinder **2** is stopped with moderation at any of the three positions by fitting of the click ball **39** into corresponding one of the recesses.

When the inner cylinder **2** has reached the OFF-position (or a predetermined position between the OFF-position and the ON-position), the movable contact **38** in the movable contact holder **34** is brought into contact with the stationary contact **36** in the stationary contact holder **35** to turn ON a power supply of the vehicle.

As can be seen from FIG. **12**, an ignition circuit **29** for the vehicle , which is operated in operative association with the switch mechanism SW, includes an interface **30**, an A/D converter **31** and CPU **32**. The stationary contact **36**, the movable contact **38**, the CPU **32**, an ignition coil **41** and a spark plug **42** are connected in series to a battery mounted in the vehicle.

The operation from the rotation of the inner cylinder **2** of the cylinder lock L by the key K to turn ON the power supply of the vehicle to the turning-ON of the ignition circuit **29** will be described below with reference to a graph in FIG. **13** and a flow chart in FIG. **14**.

When the inner cylinder **2** is turned to the OFF-position by the key K, the movable contact **38** is brought into contact with the stationary contact **36** to turn ON the power supply of the vehicle (at step S1), and the potentiometer **23** starts the detection (at step S2). When the inner cylinder **2** is turned from the OFF-position to the ON-position, the rotational angular velocity $\omega$ of the cylinder shaft **13** is varied as shown in FIG. **13A** by the action of the click ball **39** mounted in the movable contact holder **34**. Namely, the angular velocity $\omega$ is smaller until the inner cylinder **2** is started to be turned from the OFF-position at a time+$=t_1$, and the click ball **39** rides across a crest portion at a time+$=t_2$, but the angular velocity $\omega$ is larger from the time $t=t_2$ up to a time $t=t_3$ when the inner cylinder **2** reaches the ON-position, because the cylinder shaft **13** is forcibly turned by the resilient force of the spring **40**.

Therefore, as shown in FIG. **13B**, the electric resistance value R detected by the potentiometer **23** is slowly increased during a time period of $t_1<t<t_2$ while the angular velocity $\omega$ of the inner cylinder **2** is smaller, but the electric resistance value R is quickly increased during a time period of $t_2<t<t_3$ while the angular velocity $\omega$ of the inner cylinder **2** is larger. Thus, a linear derived function dR/dt (i.e., the angular velocity of the inner cylinder **2**) and a secondary derived function $d^2R/dt^2$ (i.e., an amount $\Omega$ of variation per unit time of the angular velocity of the inner cylinder **2**) with regard to the time t for the electric resistance value R are as shown in FIGS. **13C** and **13D**. The linear derived function dR/dt and the secondary derived function $d^2R/dt^2$ are calculated in the CPU **32** (at steps S3 and S4).

Then, a maximum peak value $\Omega$ a and a minimum peak value $\Omega$ b of the secondary derived function $d_2R/dt^2$ ($=\Omega$) are calculated in the CPU **32** (at steps S5 and S6). It is judged (at step S7) whether or not the maximum peak value $\Omega$ a is between reference values J1 and J2 ($J1>\Omega a>J2$) and the minimum peak value $\Omega$ b is between reference values I1 and I2 ($I1>\Omega b>I2$). If YES, the ignition is permitted by the CPU **32** (at step S8). If NO, the ignition is prohibited by the CPU **32** (at step S9).

In this manner, the ignition circuit **29** is turned ON based on the rotational angular velocity $\omega$ of the inner cylinder, when the cylinder lock L has been normally operated by the key K. Therefore, even if the cylinder lock L is broken down to cause the conduction of the contact, the ignition circuit **29** cannot be turned ON.

A second embodiment of the present invention will now be described with reference to FIGS. **15** to **19**.

A pair of cylinder pins **8**, **8** are members having the same shape and combined in their attitudes in which they have been turned through 180° with respect to an axis of the cylinder bore $1_1$ in the outer cylinder **1**. Each of the cylinder pins **8** includes a pin portion **51** having a rectangular section and engageable in a tumbler engagement groove $1_2$ in the outer cylinder **1**, and an engage portion **52** abuttable against the tip end $K_2$ of the key K. The pin portion **51** and the engage portion **52** are spaced apart from each other in a diametrical direction of the cylinder bore $1_1$ and also in an axial direction of the cylinder bore $1_1$, so that the pin portion **51** is located below the engage portion **52**.

The pin portion **51** of each of the cylinder pins **8** is formed with a spring supporting portion $51_1$ for supporting opposite ends of the spring **9** for biasing both the cylinder pins **8**, **8** away from each other, and a spring guide $51_2$ for guiding the spring **9** such as to cover one side of the spring **9**. A semi-spherical slide projection $52_1$ is provided on a lower surface of the engage portion **52** of one of the cylinder pins **8** in sliding contact with a slide surface $51_3$ formed on an upper surface of the pin portion **51** of the other cylinder pin **8**, whereby the pair of cylinder pins **8**, **8** can be slid along a cylinder pin slide groove $2_3$ in the inner cylinder **2** without being inclined relative to each other.

The engage portion **52** of each of the cylinder pins **8** includes a stepped key engage surface $52_2$. The key engage surface $52_2$ comes into sliding contact with both of an inclined surface $K_3$ formed at the tip end $K_2$ of the key K and an end wall surface $K_4$ connected to the inclined surface $K_3$, so that the pair of cylinder pins **8**, **8** are urged by the inclined surface $K_3$ and the end wall surface $K_4$ with the insertion of the key K to move the pin portions **51**, **51** away from the tumbler engagement grooves $1_2$, $1_2$ from positions of FIG. **16**A via positions of FIG. **16B**. During that time, the key engage surface $52_2$ of each of the cylinder pins **8** is in sliding contact with a portion of the inclined surface $K_3$ of the key K corresponding to about one half of the thickness T thereof, as can be seen from FIG. **16B** and hence, it is possible to reduce the wear of the tip end $K_2$ of the key K, as compared with a system in which the key engage surface $52_2$ is in sliding contact with the entire inclined surface $K_3$, thereby effectively preserving the tip end $K_2$ for positioning of the key K in a lock for a tank cap and a lock for a seat provided in a motorcycle or the like. It should be noted that a portion shown in section in FIG. **16B** is a section of the tip end $K_2$ of the key K shown in FIG. **19B**.

Although the embodiments of the present invention have been described in detail, it will be understood that the present invention is not limited to the above-described embodiments, and various modifications in design may be made without departing from the spirit and scope of the invention defined in claims.

For example, although the key switch system for the motorcycle has been exemplified in the embodiments, the present invention is applicable to a key switch system for an automotive vehicle.

What is claimed is:

**1**. A key switch system for a vehicle, comprising:

a cylinder lock comprised of an outer cylinder formed in its inner peripheral surface with axially-extending tumbler engagement grooves, an inner cylinder rotatably carried on the inner peripheral surface of the outer cylinder and having an axially extending key hole, and a plurality of tumblers radially slidably carried in the inner cylinder and capable of being engaged into said tumbler engagement grooves in the outer cylinder and disengaged from the tumbler engagement grooves by the insertion of a key into the key hole;

a steering lock mechanism operated in operative association with the rotation of the inner cylinder of said cylinder lock to lock a steering device; and

a switch mechanism operated in operative association with the rotation of said inner cylinder of said cylinder lock to turn ON an ignition circuit; wherein

said system further includes a pair of cylinder pins which are radially slidably carried in said inner cylinder to engage different ones Of said tumbler engagement grooves in said outer cylinder and having a rigidity higher than that of said tumblers, wherein said cylinder pins are disengaged from said tumbler engagement grooves by a tip end of the key coming into abutment against said cylinder pins when the key is completely inserted into said key hole, and wherein each of said pair of cylinder pins comprises a pin portion which is engageable With a corresponding one of said tumbler engagement grooves, an engage portion for receiving said tip end of the key, and a support portion for supporting a resilient means thereon which urges said pin portion in a direction to engage said corresponding one of the tumbler engagement grooves.

**2**. A key switch system for a vehicle according to claim **1**, wherein said steering lock mechanism includes a lock means advanced and retreated by the rotation of said inner cylinder to lock said steering device, and a cam means for moving said inner cylinder in an axial direction, when said inner cylinder is turned between a locking position and a lock-releasing position, said cam means being disposed between said cylinder pins and said lock means in an axial direction of said inner cylinder.

**3**. A key switch system for a vehicle according to claim **1**, wherein said switch mechanism includes a potentiometer for outputting a resistance value corresponding to the amount of rotation of said inner cylinder, and a control means for turning ON said ignition circuit in response to change in output from said potentiometer with time.

**4**. A key switch system for a vehicle according to claim **1**, wherein said engage portions of the cylinder pins are formed so as to cause the pin portions to come close to each other against the resilient force of said resilient means when the tip end of the key is urged against the engage portions.

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